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PROTOCOLS OF USERS MANIPULATING VISUALLY PRESENTED INFORMATION --ETC(U)

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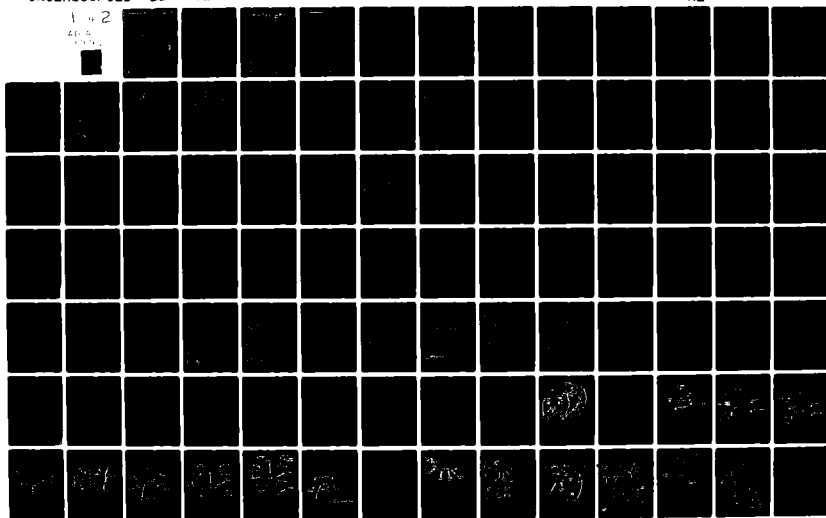
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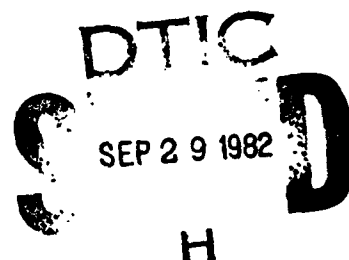
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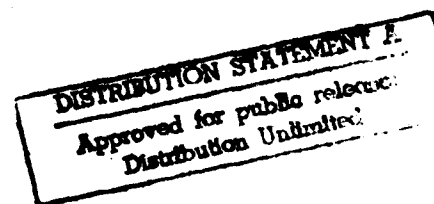
**Protocols of Users Manipulating Visually Presented Information
with Natural Language**

Candace L. Sidner

September 1982



**Prepared for:
Defense Advanced Research Projects Agency**



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Report No. 5128

**PROTOCOLS OF USERS MANIPULATING VISUALLY PRESENTED
INFORMATION WITH NATURAL LANGUAGE**

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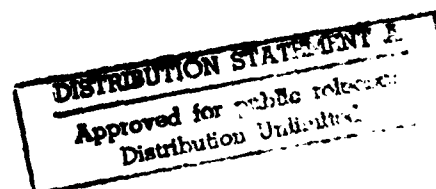
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Prepared by:

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20. Abstract (cont'd.)

cont → purpose of these protocols, and hence the design of the tasks, was to obtain data about how people talk about graphically presented material which they are trying to manipulate in some way. In particular, we were interested in the kinds of references people made and what sorts of instructions they gave to the machine.

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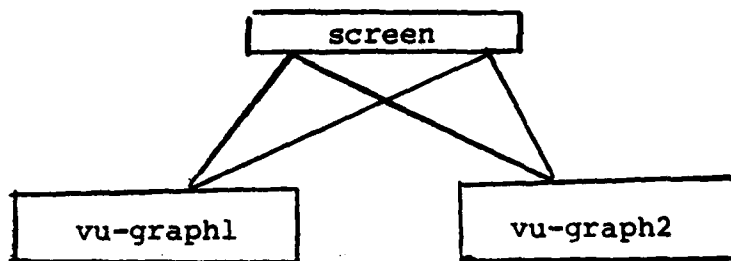
1. INTRODUCTION TO THIS PAPER

This document contains a complete set of transcripts for a set of protocols collected at BBN by Candy Sidner, with the help of Rusty Bobrow and Jeff Gibbons, in the spring of 1980. In all, eight protocols were collected, two preliminary ones and six main ones. The two preliminary protocols are based on the task of designing a 1 bit adder and a 4 bit parallel adder as are three of the main protocols, while the other three make use of KL-1 as a database system with graphic representation. The purpose of these protocols, and hence the design of the tasks, was to obtain data about how people talk about graphically presented material which they are trying to manipulate in some way. In particular, we were interested in the kinds of references people made and what sorts of instructions they gave to the machine.

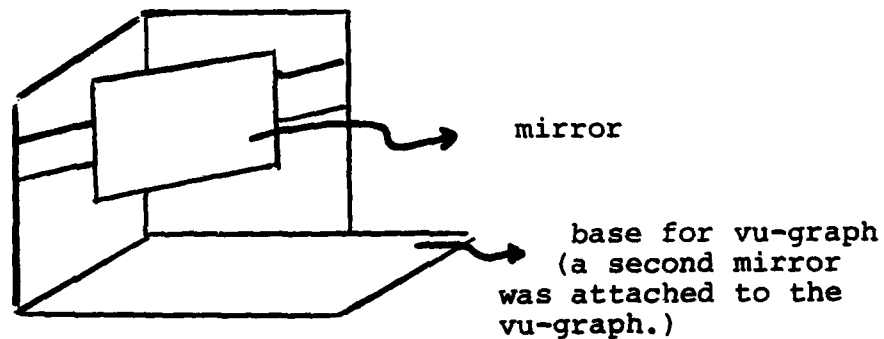
The transcripts given here contain all the instructions given both to the user and to the person who simulated a natural language understanding system, often referred to here as the system or the machine. All the graphic displays drawn and all the communication between user and system are given as well. The slides of graphic displays have not been edited or changed in any way. As a result they look somewhat cluttered, and the quality of the reproduction is poor. However, they will provide the reader with a better understanding of the interaction between user and "system."

The preliminary protocols permitted us to observe potential problems in protocol collection. Two persons, henceforth referred to as A and B, played the part of the system in both protocols, while persons C and P were users (respectively) for those sessions. A and B divided the task of being the system into one person to draw displays and the other to communicate with the user. The user and system communicated with a two way link over C100 terminals with a transcript maintained from a TELNET log file. Person B, who drew pictures, displayed them with a view graph projector and the user pointed at the display when needed. One of our discoveries was that pointing directly at the display by hand or by means of a light beam visual aid was unsatisfactory. It was clumsy and so inconvenient that the user found pointing unmanageable. Also we discovered that high load average on the machine slowed down the communication link enough to make communication too slow to be effective from the user's point of view. These problems were remedied by 1) using the machine when the system load could be kept lower by excluding other users, and 2) by building a device to make pointing possible.

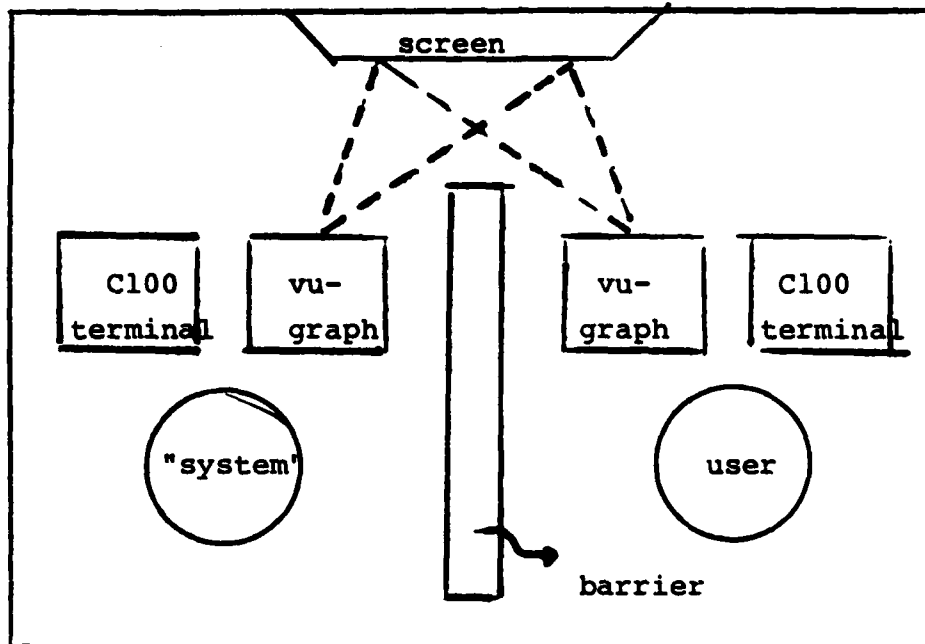
To permit both the system person and the user to point, we used two view graphs whose images were superimposed on the same place on a screen as shown below.



Our intent was to allow the system person to draw on the screen and to permit the user to point and to trace lines (the only skills needed) in much the same way that one uses a mouse. However, one problem resulted with this simple method. The images are left-right and top-bottom inverted. We discovered that it is nearly impossible to point easily with these inversions, and tracing is totally impossible. So we built two copies of a structure from which we hung 2 mirrors to "undo" the left-right, top-bottom inversions. The structure is shown below.



The layout of the room for the main protocol sessions is shown below.



Finally a note about the transcripts. Because we permitted our subjects, both user and system, to use standard tops-20 editing characters (rubout to erase characters, control-r to redisplay a line and control-w to erase whole words), the transcripts contained all kinds of control characters which had to be removed. I have retained all the deleted words, as well as inserted all the places pointed to in each slide and also what slide was in use at what point in the transcript. In the preliminary transcripts, deletions are given in parentheses as are the slide numbers and point numbers. In the main protocols, deletions are set off in brackets "[]," while pointing and slide numbers are given in angle brackets "<>." Also whenever a subject used a control-r to re-display a line, the control-r is represented with "%." All the slides are presented at the end of this report; the convention used is that slides from session one are noted as session1-1, session1-2, etc.

Slides from preliminary protocols are numbered as prelim1-1, and prelim2-1.

In the main protocols, only one person played the system after session 1. We found that two persons were not needed in that role. The subjects for the main protocols are given below. Only one protocol was taken in a given day. The last protocol was taken on two days (due to system down time). In all sessions both the user and the system person were aware that each was interacting with another person and not a machine.

System person	User
A & B	F
B	F
A	D
I	G
F	I
H	Q

Subjects were re-used for a variety of reasons. F was re-used as user to diversify the task; F and I played both system and user in an attempt to familiarize them with the general process. In the first session, A & B knew exactly what F's task was; this seemed unrealistic. In the remaining sessions, the system person was given some limited information about the task being performed. For KL-1 sessions the information is presented with the transcripts. For the logic designs, the system person was told that the user would be manipulating logic gates in an attempt to design a new gate type. Additional instructions to

the system person are given along with the transcripts.

2. TASK ONE: USING KL-1 WITH GRAPHIC DISPLAYS

2.1 Protocol One

2.1.1 Instructions to Subjects

I. Working with KL-1DB

You are going to be talking to KL-1DB, a system is capable of displaying part of a database of KL-ONE concepts on your screen. A user such as yourself can make changes in its graphic representation. You can define new concepts, change or delete old ones. You can tell KL-1DB in English what you want done, or you may ask to see any part of its current database.

YOUR TASK:

Your task is to use KL-1DB and learn to interact with it easily. To help you do so, you are asked to define the following concept for the database using the graphic display; defining a concept consists of connecting it by superc cables and role links to all the necessary related concepts.

A individual person who has a job, a hobby of golf, and whose mailing-address is 101 Main St. This person's residence is the Garden St. Apts. and his nickname is "Ducky."

In addition you must:

Inform KL-1DB that the mailing-address for a person in general is the same as the address of a person's residence.

Of course, in order to define the above concept, you will need to find out what other concepts are already known to KL-1DB, and you may need to define some concepts if they are not known. You should remember that THING forms the summum genus of KL-1DB's concept hierarchy.

II. How to talk to KL-1DB

When you interact with this system you are to use English sentences typed at your terminal. Your English should not be simplified; instead you are to use whatever way of talking is

most natural for you. You may say whatever you like; the machine will tell you if there is something it cannot understand.

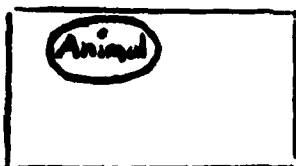
To type in English you may use standard Tops-20 editing control characters. When you feel your statement is complete, use 2 carriage returns; the carriage returns tell the machine that you have finished your statement.

If your screen picture gets too cluttered, you may also tell the machine to put a concept in a specific place on the screen or to move concepts around.

Sample:

Show me the concept for animal in the upper left corner.

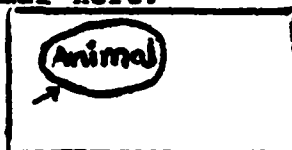
Screen:



Or

Put the concept for animal here.
(and point to the place)

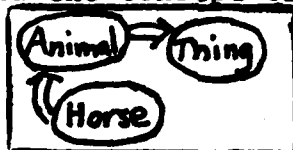
Screen:



III. A Sample Session you might have with KL-1DB

I want to define horse for the database. Put a superc cable between horse and the concept of animal.

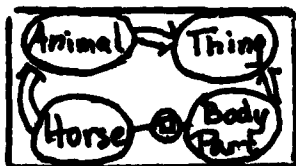
OK Screen:



(Note that KL-1DB assumes that animal and THING are related by a superc cable. Also, unless you tell KL-1DB where to put concepts on the screen, it will choose places itself.)

Horse has a tail role. Its role value is Body-part.

OK Screen:



Is Body-part defined in the database?

No.

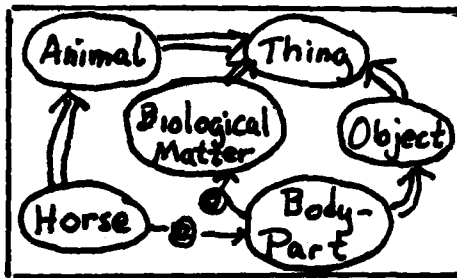
Ok, a body-part is an object which is made-of biological matter.
Put a superc cable from body-part to object and from object

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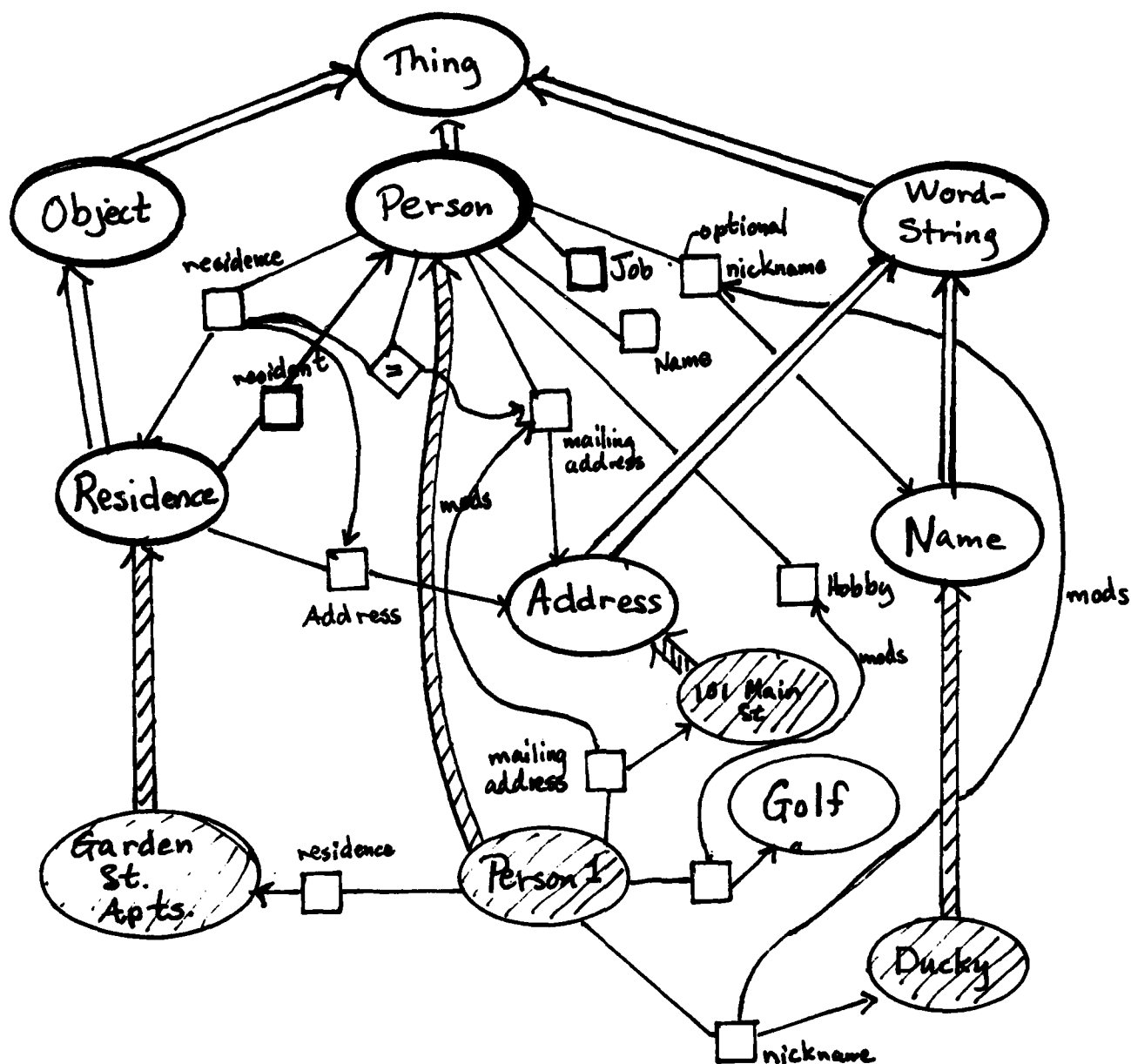
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to THING.

OK Screen:



You may begin your task now. Direct your inquiries to KL-1DB.



This diagram was given to the subjects who played the part of the system. Bold lines indicate what the system knew; hatched lines indicate what user needed to add.

2.1.2 Transcript 1

1. Protocol collection with B on display and A on TTY.
2. Protocol subject is F.

TELNET logging file started at Tue 22 Apr 80 1030:34
on connection 1 from 2 to BBND-3032400004

Good morning, Frank!

Good morning. Please show the concept Person

<slide 1>

Drawing...Ok

Add a rike c[akke]aaaaaaarrrr^A^A^A^A%

Add a rike ca[aaaaaaarrrl%

Add a [rike ca%

Add a role called hobby.

ok

make the vr be [Game]Pastime

Alright

make a subc of Pastime called [Game]Sp[rlort[rrl%

make a subc of Pastime called Sport

ok

make an iconcept of Sport called Golf

ok

is there a concept called mailing-address or something like that?

There is no concept "mailing-address". What do you mean by
"or something like that"?

An[tything that partially matches spelling of the concept name
given or
that identifies the concept indirectly via some other concept.

There is a concept called Address. Is that of help?

What role of what concept has Address as VR

It is the VR of the mailing-address

It is the VR of the mail

It is the VR of the address role of the concept residence

make a role for person called address

make a role for person called home

ok

change the rolename to residence

Is this ok?

yup

what would

what would you like next?

could you make that role be a copy of the residence

could you make that role be a copy of the address role of residence instead.

Parsing...what do you mean by "copy"?

Make a new role for person that has the same number, facet, modality and VR as the address role of residence

Drawing...ok?

name the new role mailing-address

done

make the vr of residence to be residence

ok

add a rolevaluemap to person linking mailing-address to address of residence

is this

is this what you wanted?

y

ok. what else would you like?

move the rolevaluemap to here <1>

one moment please...ok

what concepts are there with rolename [nick][rrl][rrr] %
what concepts are there with rolename like nickname or with role
having [bv]

(HOST WENT DOWN AT 11:06)

TELNET logging file started at Tue 22 Apr 80 1117:47
on connection 1 from 2 to BBND-30324000002

what concepts are there with rolename like nickname or with role having
vr named like nickname

Concepts do not havew rolenames. Also, there are no roles having VR
like nickname. There is a concept called NAME.

use concepts with roles having rolename like nickname ...

[F] %;

I cannot par[e] %
I cannot parse your request. Could you rephrase it please?

wha[concepts] %
what concepts are there having roles with rolenames like nickname?

There are no co[m] %
There are no concepts with roles name[s] %
There are no concepts with roles named anything like nickname

what concepts have roles with vr of Address besides Person
Resdidence is the only other such concept

add a roleset to Person named nickname with vr name

Whewre would you like that drwan?

above job

ok

make an individual vb %
make an individual vb %
make an individual [vbperson] %
make an individual person with nickname "Ducky"

Where should I put the IC?

there <2>

By nickname in the above request, do you mean an IROLE or a RO[E]?
By nickname in the above request, do you mean an IROLE or a ROLESSET?

are there any roles of Name?

NAME has n[b]?
NAME has no roles

use an IRole

Is "Ducky" a generic concept or an IC?

the name of an IC

ok?

make Ducky subc of Name

IC's cannot be subc to anything

red[cel]?
redefine subc to include individuation

ok

give that individual golf as a filler for hobby

Should I create an IROLE for hobby ?

in general, I user filler to de[ntore]?
in general, I user filler to denote an IROLE.

one moment please...Is this what you wanted?

y. now give him a residence filler of "Garden St. [Spartel]?
y. now give him a residence filler of "Garden St. Apartments",
an individual of Residence

Drawing...ok

give the new IC an address filler of "101 Main St.", an IC of Address

Is this correct?

no. put in the sats l[i k]?
no. put in the sats link from [hrel]?
no. put in the sats link from here <3>?
[no. put in]

Is this correct?%

Is this correct? .

yes

ok

give Person a new optional roleset called Job

Do you want a new RO[E]?

Do you want a new RO?

Do you want a [n]?

Do you want a second ROLESET JOB or should I make the old one optional?

the latter.

ok

give the [ind]?

give the IC a proleset with MODS to Job of Person

Whifuchl?

Which IC do[y]?

Which IC do you mean?

only one is possible, but this one <point to <2> again>

omakek its

number restriction 1

alright

show vr of [job]?

show vr of Job

It currently has no VR

give it occupation as vr

ok

thanks

thank you

2.2 Protocol Two

2.2.1 Preliminary Instructions

This section contains:

1. Instructions to user
2. Guidelines for system. Due to previous protocol, we determined that it would be more realistic if the system did not know what the user had been instructed to do. Hence B was given only general guidelines plus a copy of the database constructed the previous day, the database being what he as system was to know.

In today's task, you should assume that KL-1DB has retained yesterday's database. However, the network is too big to present all at once, so you will have to learn the system's conventions for displaying formation. You are to get the system's database to reflect the following:

Mortimer, who's nickname is Ducky, is an architect who specializes in the design of homes. He was educated at Princeton. His office is in Cambridge. Among his house-designs are Fallingriver and Highland Hills. Fallingriver has several features including 2 saunas, clay tennis courts and a natural water swimming pool. The house is in Pennsylvania. Mort's address has changed from the Garden St. Apartments to 400 Concord St., Lexington.

Before you begin adding in this info, check the information on residences and addresses as your new task requires some use of it and perhaps some modification.

As before, all rules about using English, pointing where necessary or convenient and use of double carriage returns applies. Please ask at the beginning of the session about rubouts and control characters as there appear to be some changes needed.

Guidelines

1. Keep the current database but do not display the roles and role value info on more than 2 concepts. If the user wants to see several concepts., show only superc links.
2. Keep your writing a consistent size and keep concepts one size as well.

3. Deleting information from the current database requires re-drawing. (Your drawing errors may be erased).

4. Getting Advice from user: Suppose you are uncertain about the best place to put a bunch of info (like a role, its rolename, value restriction, etc.)> Ak the user where he'd like it and explain why you are asking. You can volunteer (if appropriate) to show him on a fresh screen just what the whole structure looks like before he chooses a location.

5. Please label all deictic pointing on the screen with consecutive numbers.

6. Please do not talk to the user.

2.2.2 Transcript 2

This protocol was taken with B as system and F as user. The user began typing at 10:42 after reading instructions.

TELNET logging file started at Wed 23 Apr 80 1011:15
on connection 1 from 2 to BBND-30324000106

<slide 1>

HELLO, THIS IS KL1-DB

high tferel%

high tthere%

high tthere. Please show person

DO YOU WANT MORE DETAIL?

nope. change that <1> number facet to (1 NIL)

OK

Name the ICs of person

PERSON#1 IS THE ONLY IC OF PERSON

Name the PROles of person#1

THEY HAVE NO LOCAL NAMES. DO YOU WANT INHERITED NAMES?

natch. (are there any other names in this furshluginer system?

Y)ES

LOCAL NAMES! THE ONLY PROLE ON PERSON#1 IS JOB

add roleset named Nickname to Person, w/ number facet (0 NIL) and

vr TEX[ST]T%

vr TEXT

THERE APPEARS TO BE AN ERROR IN THE DISPLAY...THERE IS A ROLESSET
NAMED NICKNAME ON PERSON, AND IT ALREADY HAS A VR. DO YOU WANT
ME TO DISPLAY IT?

Change the number and vr as indicated [naland display please

WHERE WOULD YOU LIKE ME TO DISPLAY THE ROLESSET?

below hobby

OK

make a new generic called architect, with rolesets named
specialty, office address, education, designs

WHERE WOULD YOU LIKE ME TO DISPLAY IT, AND DOES IT HAVE ANY
EXPLICIT SUPERCs?

there <2>. none.

THE SYSTEM REQUIRES THAT ANY CONCEPT WITHOUT AN EXPLICIT SUPERC
BE LINKED TO THING, AND PLACING ARCHITECT WHERE YOU SPECIFY WOULD
REQUIRE A SUPERC LINK LONGER THAN NORMALLY ALLOWED. HOW SHOULD I
HANDLE THIS SITUATION?

don't show supercs. get rid of person. center architect.
<slide 2>

OK

make vr of designs structure[s]

DOES STRUCTURES HAVE A SUPERC?

unless i tell you, assume only thing

OK?

make vr of education school

OK?

y. make number facet of designs and education (0 NIL)[[]]

OK

move structure to <3>

REDRAWING...OK?
<slide 3>

save display A and show address
<slide 4>

WHAT IS DISPLAY A?

name of the current display

OK.

move ... <4> to ... <5>

OK

add rolesets streetnumber streetname community state and zip to address

THE DISPLAY IS CLUTTERED. WHERE DO YOU WANT ME TO PUT THEM?

don't show them

OK

give the IC 101mainst an irole with val 101 satisfying streetnumber
give it an irole with [main]"main st." satisfying streetname

I CANNOT DRAW SATS LINKS WITHOUT HAVINF[]%

I CANNOT DRAW SATS LINKS WITHOUT HAVIN[F]%

I CANNOT DRAW SATS LINKS WITHOUT HAVING A DESTINATION ON THE
SCREEN. HOW SHOULD I HANDLE THIS?

don't show. make the vr of streetnumber be NUMBERP, the vr of
streetname be TEX T, the vr of ZIP be NUMBERP , the vr of
community be CITY

ENTERED INTO THE DATABASE.

show person#001
<slide 5>

DO YOU MEAN PERSON#1?

Y.

DO YOU WANT A NEW DISPLAY?

Y.

WHAT SHOULD I DO WITH THE CURRENT DISPLAY?

save as display"address"

OK

make ducky ic of text not name

OK

give (not showing) GardenStSapts irole satisfying streetname with
val Garden St. , [irole]

STREETNAME IS NOT AN INHERITED ROLE NAME OF GARDENSTAPTS

name generic of gardenstapts

RESIDENCE II]%

RESIDENCE [I]%

RESIDENCE [S]

S THE SUPERC

show rolename of ... <6>

OK

get rid of name and show vr of residence there <name concept deleted>

OK

make residence a subc of structure (don't show)

OK

save display as ducky and show residence
<slide 6>

DRAWING...OK

give residence a rolename with name name and vr text

OK

give residence a role[nam]set with name features and vr LISTP

OK

make Ducky ic of architect, making new display
<slide 7>

DUCKY IS AN IC OF TEXT, AND ARCHITECT IS NOT A SUBC OF TEXT...

use person#1

FOR WHAT?

ducky

I ASSUME YOU MEAN MAKE PERSON#1 AN IC OF ARCHITECT. OK?
ce#

c[e][rr]
ccheck

OK

rename Person#1 to be ducky. show names of iroles and proles

THERE IS ALREADY A CONCEPT NAMED DUCKY. [H]WHAT?
THERE IS ALREADY A CONCEPT NAMED DUCKY. WHAT?
THERE IS ALREADY A CONCEPT NAMED DUCKY. WHAT SHOULD I DO?

make ducky not be an ic, just TEXT

TEXT IS NOT THE NAME OF A LISP DATA TYPE CONCEPT, SO ALL INDIVIDUATORS
ARE [C]KL[O]-ONE[E]!
ARE KL-ONE CONCEPTS.

chang all references to TEXT to be STRINGP

OK

at ducky fill education with Princeton, an ic of school

OK

erase all the person roles of ducky from the display
<slide 8>

OK

fill office address at Ducky with an ic of address with community
satisfised by Cambridge

WHAT IS CAMBRIDGE?

save display as B. show address (may have been saved[()]).
<slide 9>

OK

redisplay B. <slide 8> Cambrid[elge is ic of City

OK

name the vr of specialty

THERE WAS NONE GIVEN

make vr of specialty architecturalspecialty. make residence a
subc of architecturalspecialty. (don't show)

Report No. 5128

Bolt Beranek and Newman Inc.

OK

fill specialty at ducky with residence

OOK

fill designs at ducky with Fallingriver and Highland-Hills,
ics of residence (don't show)

OK

e

rase display and show

Protocol ended due to time limit. 11:45 am

2.3 Protocol Three

2.3.1 Preliminary Instructions

This section contains:

1. Instructions to user.
 2. Instructions to computer
-

I. Working with KL-1DB

You are going to be talking to KL-1DB, a system is capable of displaying part of a database of KL-ONE concepts on your screen. A user such as yourself can make changes in its graphic representation. You can define new concepts, change or delete old ones. You can tell KL-1DB in English what you want done, or you may ask to see any part of its current database.

YOUR TASK:

Your task is to use KL-1DB and learn to interact with it easily. In obtaining information about the database of concepts, you are to tell KL-1DB as much as you think useful for it about what you are trying to accomplish. KL-1DB only knows that you wish to manipulate the database, but it can be more helpful with the display depending on what you tell it about what you are up to.

To help you learn to use KL-1DB, you are asked to define the following concepts for the database using the graphic display; defining a concept consists of connecting it by superc cables and role links to all the necessary related concepts. Some of the concepts mentioned may already be in the database with partial or complete descriptions.

Bill is an employee of the company ABC. He is employed as a toe maker for ABC and he works a normal 8 hour day. He earns \$40000 a year. He also serves as an adjunct member of ABC's governing board. The board has 5 main members and 1 adjunct member. Main members make decisions while the adjunct member represents employees' interests. ABC's chief business is the design of robot toes; it's their only product. ABC has 200 robot related positions in its company, which include toe joints, nail catchers and toe padding. One competitor of ABC's, DZZ, went out of business. Delete it from the database if it is still there.

Of course, in order to define the above concepts, you will need to find out what other concepts are already known to KL-1DB, and you may need to define some concepts if they are not known. You should remember that **THING** forms the summum genus of KL-1DB's concept hierarchy.

II. How to talk to KL-1DB

When you interact with this system you are to use English sentences typed at your terminal. Your English should not be simplified; instead you are to use whatever way of talking is most natural for you. You may say whatever you like; the machine will tell you if there is something it cannot understand. If you wish to point at something on the display, use the stylus which will be given to you.

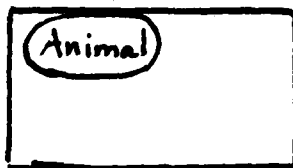
To type in English you may use standard Tops-20 editing control characters. When you feel your statement is complete, use 2 carriage returns; the carriage returns tell the machine that you have finished your statement.

If your screen picture gets too cluttered, you may also tell the machine to put a concept in a specific place on the screen or to move concepts around.

Sample:

Show me the concept for animal in the upper left corner.

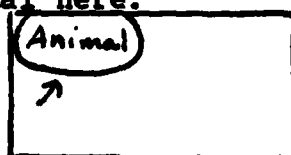
Screen:



Or

Put the concept for animal here.
(and point to the place)

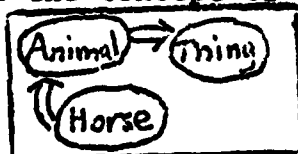
Screen:



III. A Sample Session you might have with KL-1DB

I want to define horse for the database. Put a superc cable between horse and the concept of animal.

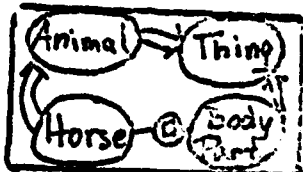
OK Screen:



(Note that KL-1DB assumes that animal and **THING** are related by a superc cable. Also, unless you tell KL-1DB where to put concepts on the screen, it will choose places itself.)

Horse has a tail role. Its role value is Body-part.

OK Screen:

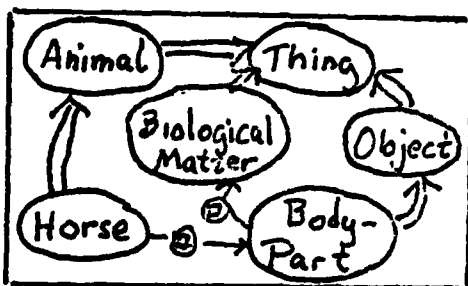


Is Body-part defined in the database?

No.

Ok, a body-part is an object which is made-of biological matter. Put a superc cable from body-part to object and from object to THING.

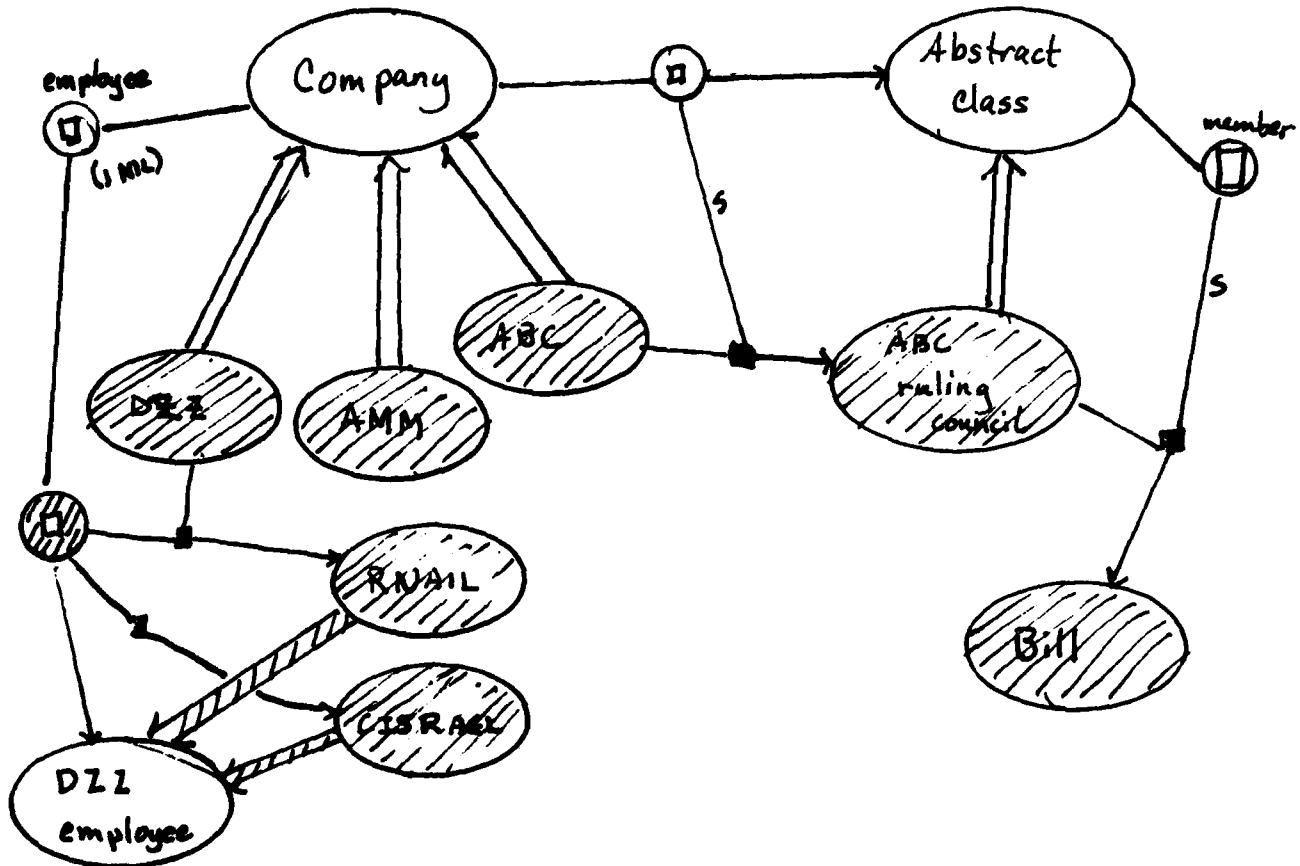
OK Screen:



You may begin your task now. Direct your inquiries to KL-1DB.

Guidelines

1. Keep the current database but do not display the roles and role value info on more than 2 concepts. If the user wants to see several concepts., show only superc links.
 2. Keep your writing a consistent size and keep concepts one size as well.
 3. Deleting information from the current database requires re-drawing. (Your drawing errors may be erased).
 4. Getting Advice from user: Suppose you are uncertain about the best place to put a bunch of info (like a role, its rolename, value restriction, etc.)> Ask the user where he'd like it and explain why you are asking. You can volunteer (if appropriate) to show him on a fresh screen just what the whole structure looks like before he chooses a location.
 5. Please label all deictic pointing on the screen with consecutive numbers.
 6. Please do not talk to the user.
-



This picture displays what A was told to assume as the KL-1 database for the start of the session. A is a knowledgeable KL-1

user.

2.3.2 Transcript 3

Protocol collection with A as system person and D as user.

TELNET logging file started at Thu 24 Apr 80 1008:46
on connection 1 from 2 to BBND-30324000100

<slide 1>
HELLO. THIS IS KL1-DB .
GOOD MORNING. OVER

Ok, first thing that I'd like to see is the representation for
:Companies.

I KNOW ABOUT A GENERIC [COM] %
I KNOW ABOUT A GENERIC CONCEPT COMPANY. IS THAT WHAT YOU WOULD LIKE?

Uh huh.

OK
DRAWING...OK

I [s] assume ruling council is a synon[t]ym [g] for g[l] overning board

I DON'T KNOW THAT SYNONYM. DO YOU WANT ME TO USE IT IN THE FUTURE?

Yes, "ruling council" is grotesque. Can I assume that from now on
when I ta;k about governing boards you'll knmow that I'm talking
about what you use to call "ru;l;ing councilsd"?

YES, WOULD YOU LIKE ME [YTO RE] %
YES, WOULD YOU LIKE ME TO RENAME THE ROLE CALLED ROULING COUNCIL TO BE
GOVERNING BOARD?

Yes, if it's not too much trouble.

NO TROUBLE AT ALL..OK

Thanks; now s[k] %
Thanks; now show me the concept for persons

I AM SORRY, BUT I KNOW OF NO SUCH CONCEPT

EEK; do you have a concept:Employee?

I HAVE A CONCEPT FOR "DZZ EMPLOYEE". IS THAT OF HELP?

Not much. So first put a V\R link off the role "employee" on

"company" and label the generic:Employee. Then draw a SuperC cable from it up to a concept labelled "pers[el]on."

OK. DRAWING...OK. BY THE WAY, YOU NEED NOT USE QUOTES WHEN [RN] %
OK. DRAWING...OK. BY THE WAY, YOU NEED NOT USE QUOTES WHEN [M] %
OK. DRAWING...OK. BY THE WAY, YOU NEED NOT USE QUOTES WHEN CONTEXT IS SUFFICIENT TO INDICATE LABELS.

Fine. Now give me an individual concept for a person named Bill.

[BY THE PHA]BY THE PHRASE "NAMED BILL" DO YOU MEAN TO LABEL THE IC BILL?

I guess so; since that's the way you seem to have handled the twi[e] %
I guess so; since that's the way you seem to have handled the two [indic]individual company concepts you 'H've shown me.

OK...IS THERE A GENERIC] %
OK...I[S THERE] %
OK...[I] %
OK...WHERE WOULD YOU LIKE TH[] %
OK...WHERE WOULD YOU LIKE THE IC TO APPE[R] %
OK...WHERE WOULD YOU LIKE THE IC TO APPEAR?

<pointing not shown in slide2>

I AM AFRAID THAT THAT SPOT WILL MAKE THE SCREEN TOO CLUTTERED. WOULD YOU LIKE TO MAKE ANY SUGGESTIONS ABOUT WHAT I DO?

No, you're the expert on screen clutter. I wouldn't have thought my original suggestion was too bad.

OK, YOU ARE THE BOSS...OK

Ok, now how I do say tha[r] %
Ok, now how I do say that Bill is an...Woops, I forgot ab[p] %
Ok, now how I do say that Bill is an...Woops, I forgot about ABC.
[I nn]I need an individual concept for the company ABC

OK. WHERE WOULD YOU LIKE IT. AS THE SCREEN BECOMES [MOR] %
OK. WHERE WOULD YOU LIKE IT. AS THE SCREEN BECOMES FILLED, I NEED YOUR HELP ON LAYOUT DECISIONS.

Even if I'm lousy at such things? Can't you figure these things out fo[t] %
Even if I'm lousy at such things? Can't you figure these things out for me?

YES, BUT I DO LACK SOME CONTEXT OF YOUR GOALS WHICH COULD HELP IN THE PROCESS. NONETHELESS, I WILL MAKE SUCH DECISIONS IN THE FUTURE UNLESS YOU SPECIFY OTHERWISE...DRAWING...OK

<slide 2>

Fine; I should have said that I'll be putting in a fair amount of information about Bill and about ABC> Now back to Bill; How do I say that Bill is an employee of ABC?

I DON'T KNOW ABOUT CONSTRUCTING KL-ONE STRUCTURES IN GENERAL BUT I DO HAVE IN MY DATABASE SOME IC'S WHICH ARE EMPLOYEES OF DZZ. MAYBE LOOKING AT THAT STRUCTURE WILL BE OF HELP.

Good, can I see some of that stuff.

IS THIS OF ANY HELP?

Not much. What ^H's the weird structure just above the DZZ employee concept?
Not much. What ^H's the weird structure just above the DZZ employee concept?

IS ^H'S A CASE OF PROFANITY?

No, sorry, it's a case of bad typing. I just meant to say ;what's the...

OK...SORRY...I DON'T KNOW WHICH STRUCTURE ABOVE DZZ EMPLOYEE YOU MEAN. THERE ARE MANY STRUCTURES ABOVE THAT CONCEPT. MAYBE YOU COULD POINT TO THE ONE YOU MEAN.
THE ONE YOU MEAN THE ONE YOU MEAN.

This one <2>

THAT IS A PARTICULAR ROLESET.

Well ok; make one of those up for ABC's employees and draw in an individual cable between Bill and it

Can I interrupt?
Can I interrupt?

YES

Sorry, while you're at it, [t]
Sorry, while you're at it, you can delete the concept for DZZ employees and for Israel and RNAIL(?) and all their links, I think.

DO YOU WANT THESE CONCEPTS DELETED FROM THE DATA BASE? [CONFIRM]

No, just from the picture.

OK. YOU JUST WANT THEM ERASED...DRAWING...HOW IS THIS? <slide 3>

Better. Ok now I need some role attached to employee. First, a role

labelled salary, [thl%
 labelled salary per year; then one labelled length in hours of workday;
 then one for jobdescrip%
 then one for jobdescription.

DRAWING...

Can i interrupt again. The VR on salary should be Number of dollars, that on workday should be Number of hoursd, and that on jobdescription should be Activityy. Do you already have a conceptActivity?

I HAVE NO CONCEPT FOR ACTIVITY. BY THE WAY, YOU NEEDN'T INTERRUPT TO MAKE ADDITIONS. ONLY, PERHAPS, IF YOU WANT TO CO[O]%.
 ADDITIONS. ONLY, PERHAPS, IF YOU WANT TO CORRECT WHAT YOU LAST SAID.
 DRAWING...OK?

Yeah I glil%
 Yeah I guess so. This langlyl%
 Yeah I guess so. This language sur is klunky. Oh well; by the way do I get the roles we've just put on Employee for free on ABC employee?

THERE IS NO KNOWN CONN[C]%.
 THERE IS NO KNOWN CONNECTION BETWEEN EMPLOYEE AND ABC EMPLOYEE

Ok put in a SUpoerC cable between t[ol]%.
 Ok put in a SUpoerC cable between the two; then ...then what?
 Then make up another concept - a generic- which has a superC linkk to ABC employee and which has as Val[e]%.
 to ABC employee and which has as Value on its salry role \$40000, as value on its workday * hours, and as[job]%.
 value on its workday * hours, and asVR on its job description a subconcept of activity labelled making artifacts with a role for artifact type .More later; let's see what you've got so far

WOW! PERHAPS WE SHOULD HAVE LESS PER REQUEST SO WE STAY TOGETHER ON THINGS.
 FIRST OF ALL, WHICH WAY WOULD YOU LIKE THE FIRST SUPER[S]%.
 FIRST OF ALL, WHICH WAY WOULD YOU LIKE THE FIRST SUPERC YOU MENTIONED TOP POINT?

From ABC employee up to Employee

<slide 4>

OK...DOES WORKDAY * HOURS REFER TO THE ROLE LEN[T]%.
 OK...DOES WORKDAY * HOURS REFER TO THE ROLE LENGTH IN HOURS OF WORKDAY?

Sorty I meant that the value should be 8 hours

THEN [DO]%

[THEN]

WHAT SHOULD BE [YTH]%

WHAT SHOULD BE THE LABEL FOR THIS CONCEPT? <1>

Does it need a label?

NO, I WILL MAKE ONE UP FOR REFERENCE PURPOSES. OK

I take it that the things on the end of the two Val links are Individual, not generic concepts

THEY ARE CURRENT[]%

THEY ARE CURRENTLY GENERICS. SHOULD I CHANGE THEM?

Yes

OK

Now on artifact type , the VR is artifact , and I will need only one superc under it, namely robot toes. Woops, of course artifacts are physical objects, which have partsd which are themselves physical objectsd. Can I have all that; o[t]l%
physical objectsd. Can I have all that; o heaven forbi[r]l%
physical objectsd. Can I have all that; o heaven forbid , do you know some of that already?

NO, AND THE SCREEN IS CERTAINLY EXCEEDING MY CLUT[EER]%

NO, AND THE SCREEN IS CERTAINLY EXCEEDING MY CLUTTER FACTOR. WO[PULD]%

NO, AND THE SCREEN IS CERTAINLY EXCEEDING MY CLUTTER FACTOR. WOULD YOU LIKE A FRESH SCREEN FOCUSSED ON MAKING ARTIFACTS?

Yes, but [you]l%

Yes, but can you keep track of the old screen and the connections between [what]l%

Yes, but can you keep track of the old screen and the connections between it

and what'll go on the new screen?

I HOPE SO. OK?

<slide 5>

Fine, but now I realized that I goofed . I also need another superc under

activity , namelt ;desi[n]l%

activity , namelt ;designing artifacts. That's back on the old screen.

I think I'll need t[i]l%

I think I'll need to see it again.

CAN I JUST SHOW YOU THE PAR[E]l%

CAN I JUST SHOW YOU THE PART OF THE OLD SCREEN RELATING TO ACTIVITY?

Please do

ONE MOMENT PLEASE...OK?
<slide 6>

Good. now put a part role on robot toes whose VR is unlabelled [w] %
Good. now put a part role on robot toes whose VR is unlabelled
and which is superc'ed aup top physical objects, and under it put
three generics labelled toe joints, nail catchers, and toe
padding. That'll finish this little bit

DRAWING (SIGH)...OK

you fogot the cables

YOU DIDN'T ASK FOR ANY

AAARRGH. What did you think I meant b[ul] %
AAARRGH. What did you think I meant by underr?

I THOUGHT YOU MEANT UNDER THE GENERIC ON THE SCREEN. WAS I WRONG?

Yes, I didn'T realize you were so bloody literal-minded. Well after
puttingf in ther cables, I'm going to need to see some of
the ol[s] %
puttingf in ther cables, I'm going to need to see some of
the old screen afl %
puttingf in ther cables, I'm going to need to see some of
the old screen again-
the part that relates to Bill's being an employee of SABC

HOST NOT RES[PNO]DING] %
HOST NOT RESPONDING.....

3. TASK TWO: DESIGNING LOGIC CIRCUITS

3.1 Instructions for Task for All Subjects

This section records three protocols centered on the task of designing and displaying a 1 bit adder and a 4 bit parallel adder. Nearly the same instructions were given to all three subjects. The instructions are shown below and the added paragraph for sessions #5 and #6 are shown in parentheses. The change was introduced in an attempt to encourage subjects to be more natural with the system. All three subjects made use of a review sheet which is all given below. Guidelines to the system subjects were available for sessions 5 and 6, but for session #4, the system subject was instructed verbally.

Task 1

The purpose of this task is to give you experience interacting with a computer in English. You will be talking about objects on a display and you are to become as experienced as you can in getting the machine to do what you want in a way that is quick and easy for you.

Here is your task:

- (a) to design a 1 bit adder,
- (b) to display it on the screen, and
- (c) to explain its input and output behavior to the machine for later use.

(ALTERNATE VERSION: The purpose of this task is to give you experience interacting with a computer in English. You will be talking about objects on a display and you are to become as experienced as you can in guiding the machine to assist you with the task you will be asked to do. You may find it helpful to explain what you are doing as you work.

Here is your task:

- (a) to design a 1 bit adder,
- (b) to display it on the screen, and
- (c) to explain its input and output behavior to the machine for later use.

Please note that the machine doesn't know what task you are about to do. It knows only that you want it to do something involving display of logic gates and their use in design.)

This task includes determining what logic gates to use and how to connect them. A 1 bit adder is a "machine" which takes in two bits of information and produces their sum and a carry (if any) as output. If you need review on designing logic circuits, ask Candy for a review "sheet."

To define the adder, you will first have to work out its design. You may use scratch paper for drawing any truth tables or logical connectives you like, but please do not draw diagrams of the circuit on paper. Do all your circuit diagrams, even if you find you must change your mind, on the screen.

To build up the display of the adder, you simply place its layout on the screen. The machine has knowledge of AND, OR and NOT gates. It also knows that logical devices have input and output terminals. You will need to tell it where to put the input and output nodes and logic gates on the screen. You may point on the display wherever you feel appropriate, or you may state locations in English. To route the wires, trace out the line on your screen and the machine will fill in your traced line.

The graphic representations the system uses for the gates are given below.



Input and output terminals are represented as

either lines:



or nodes:



In explaining the adder's behavior, your job is to make clear what the correspondence is between the use of logic gates and the notions of summing and carrying in an adder. That is, you are to explain why what an adder does is modelled by the way the logical circuit acts. Try to keep your description brief. The machine may ask you questions about your explanation especially for clarification of unfamiliar technical terms. Also, the machine will internalize your description for later use.

When you interact with this system, you should:

1. Type in English. Do not simplify your English; instead you are to use whatever way of talking is most natural for you. You may say whatever you like; the machine will tell you if there is something it cannot understand.
2. Use standard Tops-20 editing control characters.
3. When you are finished saying what you want, use 2 carriage returns; the carriage returns tell the machine that you have finished your statement.
4. You may use instructions which describe places and things in words as in: "Put an AND gate in the upper left corner" or you may use the mouse to point as in: "Display an AND gate here."
5. Give the machine general information about the device as in: "A 1 bit adder consists of 2 inputs and 2 outputs. The inputs I'll call A and B, and the outputs are sum and carry."
6. You can instruct the machine to erase any part of the screen or to move objects around on it.

Part 2

(c2) Now use the 1 bit adder to make a parallel 4-bit binary adder. Again you will explain and picture the binary adder for the machine. You can use logic gates as needed and have the machine erase or change any part of a picture. You will again use English in the same fashion as the first task.

As before, you will not have scratch paper to use in diagramming the circuit. You are to do all your diagramming on the display and to use scratch paper only for other kinds of notes.

The 1 bit adder you made before can be used as you see fit to get the binary adder. Remember that a parallel adder adds 2 4-bit binary numbers (such as 1011 and 1111) by adding the rightmost binary columns first and then propagating left. A parallel adder has a sum of 5 bits, the last bit resulting from a high order carry on the other bits. For example, in adding 1011 and 1111, the last two digits produce a carry.

-----Review Sheet-----

I. Review of constructing logic circuits

To make this task a little easier, let's review what the truth tables for AND, OR and NOT are, and how to construct a simple logic circuit from a truth table specification.

The truth tables:

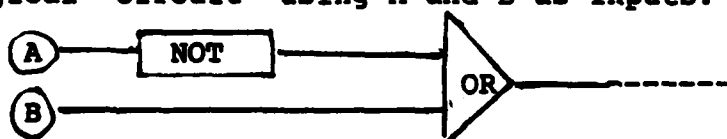
A	B	AND	OR	NOT A
1	1	1	1	0
1	0	0	1	
0	1	0	1	1
0	0	0	0	

Given a truth table like the one below, to find the logical connective representation of it, express each line of the table which has result 1 by the conjunction of the truth and falsity of the components. Thus for the first line of the table below, since A is true and B is true, it is expressed as $(A \& B)$, while for the second line, A is false and B is true, which is expressed as $(\neg A \& B)$; line 4 is expressed as $(\neg A \& \neg B)$. Finally, connect the conjunctions as a series of disjunctions. For the case below, $(A \& B) \text{ OR } (\neg A \& B) \text{ OR } (\neg A \& \neg B)$. This case can be simplified using the rule " $(A \& B) \text{ OR } (\neg A \& B) = B$ " to get $(B \text{ OR } (\neg A \& \neg B))$. Since this equation shows that either B is true or when B is false, the equation depends on $\neg A$, the whole equation can be simplified to $(\neg A \text{ OR } B)$.

Example table:

A	B	RESULT
1	1	1
0	1	1
1	0	0
0	0	1

Now take the logical connective representation, and turn it into a logical "circuit" using A and B as inputs:



For designing a 1 bit adder you will need the following table:

A	B	SUM	CARRY
1	1	0	1
1	0	1	0
0	1	1	0
0	0	0	0

-----Guidelines to system subject-----
 Guidelines

1. During this session you are to talk like a person--don't clip your comments, do use pronouns, use informal phrases and in general sound normal.

2. Make sure you understand what the thing is that you have been asked to construct by the time the task is completed.
3. When you construct a new object on the screen for the user, you may represent it afterwards as a primitive--make up a gate type for it and a display form. Tell the user what you are doing and make sure it's okay with him. It's possible that some users will take the initiative in making up a gate type. Let them, but when they don't do so yourself.
4. Mark all things the user points to with a number and a dot. Do not erase these under any conditions. Refuse to erase them if the user asks you to. Your excuse is that user points are used for later analysis.
5. Keep your writing a consistent size and keep gates one size as well.
6. Please do not talk to the user.

3.2 Protocol Four

3.2.1 Transcript 4

Task begun at 10:25
Ptip slowness between 11:05 and 11:15
Protocol collection stopped at 11:45

This protocol was conducted with subject G and system person I.

TELNET logging file started at Fri 25 Apr 80 1018:36
on connection 1 from 2 to BBND-30324000056

rem
Type remark. End with CTRL/Z.

<slide 1>

LETS GO

draw a AND gate here <1>

OK

label this input terminal A <2>

OK

label this in[m][R] %
label this input terminal B <3>

OK

1
abel this output terminal CARRY <4>

OK

put a NOT gate here <5>

OK

put a connection between the input to the NOT gate and the terminal
marked B on the AND gate.

OK

put a NOT gate here <6>

OK

put a connection between the input to the lower NOT gate and the terminal marked A on the AND gate
marked A on the AND gate.

OK

label this point A1 <7>

OK

label this point B1 <8>

OK

put an OR gate here <9>

OK

put an AND gate [*c]t
put an AND gate (and label it AND2) here <10>

OKEY DOKEY

label the topmost AND gate AND1.

OK

put another AND gate here and label it AND[2]t <11>
put another AND gate here and label it AND3

OK

label the output terminal of the OR gate SUM

OK

connect the output of AND2 to the topmost input of the OR gate [*]t
connect the output of AND2 to the topmost input of the OR gate
(label that
OR gate OR1, too[.]t
OR gate OR1, too

OK

connect the output of and3 to the lower input of OR1

OK

put a connection from here <12>

to here <13>

OK

put a connection from here <14>

to here <15>

OK

put a connection from A1 to t[th]%

put a connection from A1 to the empty input of AND2

OK

put a connection from B1 to the empty input of AND3

OK

Call this whole circuit[ADDER for future reference]

put a node here and mark it A. <16>

OK

connect A to here <17>

WHICH A?

the last one you marked

OK

move the connection [from]%

move the connection between 16 and 17 along with the node A at
connection 16 down so that node 7 and 17 coincide.

DRAWING...OK <slide 2>

remove terminals 16 and 17 and there labels.

SORRY BUT CANNOT REMOVE USER POINTS

put a node labelled B here <18>

OK

connect node B to here <19>

OK

Call this circuit a "binary adder" and save it!
 Call this circuit a "binary adder" and save it for future reference. The adder is composed of 3 AND gates, 2 NOT gates and an OR gate.

"BINARY ADDER" CIRCUIT HAS BEEN SAVED. WHAT DOES IT DO?

The adder is given two inputs (A and B--corresponding to nodes A and B on the screen) [the screen] [whole line is erased and previous line up to "inputs"]
 The adder is given two inputs [!]
 The adder is given two inputs (A and B--corresponding to nodes A and B on the screen). It produces two outputs--SUM and CARRY.

PLEASE NOTE THAT I HAVE AN EXCELLENT SPELLING CORRECTOR.
 WHAT ARE THE TWO OUTPUTS?

One output is SUM which is here <20>

IOK

The other output is CARRY which is here <21>

OK. DO THEY RELATE TO THE INPUT NODE A AND B?

They relate to the nodes A and B by the following logic formula.
 $CARRY = A \& B$
 $SUM = (A \& \neg B) \vee (\neg A \& B)$

DOES "ADDER" HAVE ANYTHING TO DO WITH ADDITION?

Yes, the circuit adds A and B producing a sum [*SUM]
 Yes, the circuit adds A and B producing a sum (S[I])
 Yes, the circuit adds A and B producing a sum (SUM) and a carry [*CA]
 Yes, the circuit adds A and B producing a sum (SUM) and a carry (CARRY).

OK.

Clear the screen!
 Clear the screen saving the circuit marked [R]
 Clear the screen saving the circuit marked BINARY ADDER.

<slide 3>
 ALREADY SAVED.

reduce the size of the binary adders so that four of them can be stacked one above the other on the left half of the screen. Draw [four]
 one above the other on the left half of the screen. Draw them.

SHALL I CREATE A NEW ICON TO REPRESENT A BINARY ADDER?

what is an ICON?

A GRAPHICAL SYMBOL.

FOR EXAMPLE, THE [S]%

FOR EXAMPLE, THE GRAPHICAL SYMBOL FOR AN AND GATE IS AN ICON.

yes. create [a]%

yes. create an ICON for a binary adder. give it two inputs and two outputs.

OK.

as I touch each point respectively, label them [line erased by ^u]

as I touch successive points on the screen, label them [line erased by ^u]

as I touch successive points on the screen, label them in the order

A1,B1,CARRY1,SUM1,A2,B2,CAR[E]%

A1,B1,CARRY1,SUM1,A2,B2,CARRY2,SUM2,A3,B3,CARRY3,SUM3,A4,B4,CARRY4, and SUM[\$ re][R]%

SUM4 respectively.

<points are not labelled with numbers for this case>

PLEASE NOTE THAT I AM FAMILIAR WITH SEQUENTIAL LABELING.

OK...

put another binary adder here <1>

OK

label it [line erased by ^u]

what is seq[e]%

what is sequential labeling?

SHALL I LABEL THIS NEW ADDER WITH 5'S?

yes

OK

connect carry1 to A5

OK

connect carry2 to b5

OK

put another adder with nodes label with 6's her4e. <2>

Report No. 5128

Bolt Beranek and Newman Inc.

OK

3.3 Protocol Five

3.3.1 Transcript 5

This is a protocol between I as user and F as the system. The user saw fairly quickly how to construct the one bit adder, but as the transcript shows the parallel adder stumped him within the time allowed.

TELNET logging file started at Thu 1 May 80 1008:48
on connection 1 from 2 to BBND-30324000020

<time for start of discussion was 10:34. Slide 1>
Please don't put your feet on the console ... thank you.

ha ha

no drawing on the glass

ha ha

you may swap out for a minute

then again I may not ...

put an [san]t
put an and gate here <1>

OK?

fine.

put a not gate here <2>

would you like a NAND instead?

is a NAND equal to NOT(a AND b)?

yes.

why sure! and put it where i had wanted [x]t
why sure! and put it where i had wanted the or gate

we don't have any OR gates yet. do you me[an]al[anrr]t
we don't have any OR gates yet. do you mean the AND?

no, i mean here <3>

you do want me to remove the AND gate first?

yes, s'il vous plait.

OK <erasure at 1; NAND gate at 2,3>

OK?

fine.

[place an OR gate]

[shouldn't you]

Can you please print in upper case only?

CERTAINEMENT.

place an OR gate here <4>

OK?

Whoops! I meant an AND gate, not an OR.

REDRAWING ...OK? <slide 2>

Whoops again! i wanted the last AND gate over here. <5>

REDRAWING ... OK? <slide 3>

connect the output of the NAND to the top input of the AND

OK?

put an OR gate here <1>

OK?

connect its output to the other input of the AND

OK?

connect the two closest inputs of the NAND and OR

OK?

place a node here and label it "A". <2>

(user types out of turn)conn (while system types)OK?

connect A to here <3>

REMARK command Used 0:00:01.8 in 0:56:05, Load 6.95

OK?

for the unused inoput%

REMARK command Used 0:00:01.8 in 0:58:18, Load 10.99

for the unused i[noput]%

for the unused inputs for the NA[M]%

for the unused inputs for the NA%

for the unused inputs for the NAND and OR, extend them a little
and then connect them

OK?

you even did it in the right oprder. place a node here and label
it "B". <4>

OK?

connect it to here <5>

OK?

lebel this output "SUM[:]%"

lebel this output "SUM" <6>

ASSUMING YOU MEAN LABEL AND NOT LIBEL ..[][.RRR]%

ASSUMING YOU MEAN LABEL AND NOT LIBEL ... OK?

you are correct. place an AND gate here <7>

OK?

connect its lower inpout to B

TO B THE NODE, OR TO ANY CONVE[ITN]%

TO B THE NODE, OR TO ANY CONVEN[E]%

TO B THE NODE, OR TO ANY CONVENIENT CONNECTION TO B?

either

OK?

lovely. connect the other input to A

OK?

label this output "CARRY"

OK?

time out for reading instructions...

WE MACHINES ARE PATIENT T[1]YPES%
WE MACHINES ARE PATIENT TYPES ...

I thought doctors were patient types?

I AM NOT PROGRAMMED TO UNDERSTAND YOUR JOKES (?)

call this circuit a "one bit adder"

OK?

very nice. erase the screen

The one bit adder takes two binary inputs and computes their sum.
Does that make sense to you?

YES.

The sum is limited to 0 or 1, hence the CARRY is used to
indicate overflow%
The sum is limited to 0 or 1, hence the CARRY is used to indicate
overflow.

I AM INTERPRETING THESE STATEMENTS AS STIPULATIONS ABOUT THE
CIRCUIT 1BA, WITHOUT CHECKING THE LOGIC OF THE CIRCUIT ...

That's ok, people are incapable of errors

SNICKER

WHY ARE YOU TELLING ME THESE THINGS?

so you may have an understanding of the purpose of the circuit.

place 3 lba circuits at the following points.%
place 3 lba circuits at the following points.

(system down)

TELNET logging file started at Thu 1 May 80 1134:22
on connection 1 from 2 to BBND-30324000060

Used 0:00:01.5 in 0:01:57, Load 18.52

rem

Type remark. End with CTRL/Z.

(retyping) place 3 lba circuits at the followin[flg%
(retyping) place 3 lba circuits at the following points. <slide
4> <points 1, 2, 3>

[ok]OK?

label the topmost input "I0"

THIS LOOKS LIKE IT MIGHT GET COMPLICATED. SHALL I EXTEND THE
TOPMOST INPUT BACK TO A COMMON INPUT COLUMN ON THE LEFT HAND EDGE
OF THE DISPLAY?

yes and inst[rl%
yes and instead of labeling the input, connect it to a node
labeled "I0" here. <4>

OKp?ut

put a node "

(system down)

TELNET logging file started at Thu 1 May 80 1155:07
on connection 1 from 2 to BBND-30324000006

REM

Type remark. End with CTRL/Z.

put a new node "B0[l%
put a new node "B0" just under I0 and connect it to the other input

OK?

rename I0 to be A0 <erasure on figure at 4>

OK?

label the topmost SUM out put to be C0

SHALL I MOVE THE OUTPUT NODE TO A COMMON OUTPUT COLUMN ON THE RIGHT EDGE
OF THE DISPLAY?

yes

O[M]?

connect the CARRY to the input of the 2nd lba

OK?

make a new [node]%
make a new input node, A1, and connect it to the second input

OK?

BY THE WAY, POINTING IS SOMETIMES EASIER THAN DESCRIBING (I ONLY MENTION
THIS BECAUS[]%
THIS BECAUSE LOOKING AT TABLET INPUT IS EASIER THAN PARSING ...)

[connect]rethinking...

IF YOU THINK I AM GOING TO DRAW A WHOLE NEW DISPLAY YOU CAN JUST
RETHINK AGAIN!

WILL THE SYSTEM BE COMING UP AGAIN SOON?

no and screw off

S[S]HALL I EXPUNGE ALSO?

Protocol ended at 12:10

3.4 Protocol Six

3.4.1 Transcript 6

This is a protocol between user H and system person Q.
This protocol was taken in two sessions.

TELNET logging file started at Fri 2 May 80 1001:31
on connection 1 from 2 to BBND-30324000110

<user started typing at 10:20>

<slide 1>

REMARK command Used 0:00:00.9 in 0:03:02, Load 12.93

TESTING...

HI, JPHN. WELCOME TO THE LOGIC MACHINE. HOW CAN I BE OF ASSISTANCE?

This is a telstl%

This is a te

hello logic machine. You can help me design a 1-bit adder.

OKAY.

do you know what one is?

NO.

Ok. Well, to quote the boofd, l%

Ok. Well, to quote the book, a 1-bit adder takes two inputs and gives two outputs. The inputs [a]I'll name P and Q, and the outputs Sum and Carry.

I PRES[EUM]%

I PRESUME THEN THAT A 1-BIT ADDER IS A LOGIC STRUCTURE OF SOME SORT, SINCE IT HAS INPUT AND OUTPUTS. IS THAT CORRECT?

yes.

OKAY. I ALSO PRESUME THAT "THE BOOK" IS IR[EE]%

OKAY. I ALSO PRESUME THAT "THE BOOK" IS IRRELEVANT[].%

OKAY. I ALSO PRESUME THAT "THE BOOK" IS IRRELEVANT[.]%

OKAY. I ALSO PRESUME THAT "THE BOOK" IS IRRELEVANT. P[LEASE GO ON WITH YOUR DESCRIPTION OF A 1-BIT-ADDER.

Do you know about logic gates?

YES. DO YOU?

Well, I think there are three kinds: and, or and not. Right?
From these one can build any sort of complex logic structure.

YE[X]S%

YES, THOSE ARE THE THREE KINDS OF GATES THAT I KNOW ABOUT.

HOWEVER, I DO NOT KNOW [HOW TO PROVE]%

HOWEVER, I DO NOT KNOW [PW]%

HOWEVER, I DO NOT KNOW HOW TO PROVE THINGS ABOUT LOGIC CIRCUITS
(OTHER THAN TO [TEST]%)

HOWEVER, I DO NOT KNOW HOW TO PROVE THINGS ABOUT LOGIC CIRCUITS
(OTHER THAN TO TEST THEM ON GIVEN INPUT VALUES) AND SO I CANNOT
TELL IF YOU CAN BUILD ANYTHING YOU WANT OUT OF THEM.

we';lll worry about showing that the adder I build with your
assistance works later on. Let's build it first.

BUI[U]%

BUILD AWAY...

REMARK command Used 0:00:02.4 in 0:30:57, Load 16.88

REMARK command Used 0:00:02.5 in 0:31:02, Load 17.75

I need 3 and gates. Place them vertically in the middle of the
screen, please.

OKAY... HOW MANY [INPUTS DO YOU WANT ON THEM]%

OKAY... [HOW MANY]%

OKAY...

between the top two and gates a little to the right place
an or gate. The inputs from the or gate come from the and gates.
Label its output sum.

OKAY

do you know how to make diagrams pretty?

WHAT'S "PRETTYY MEAN?

JOHN? IF YOU KNOW WHAT PRETTY MEANS, YOU CAN POINT TO THINGS ON
THE SCREEN AND TE[,L]%

THE SCREEN AND TELL ME WHERE TO PUT THEM.

THAT WAY YOU WILL NOT HAVE TO EXPLAIN "PRETTY" TO ME.

We[k]lll, for now, put a not gate in front of the first input to
the top and gate and the second input to the middle and gate.

SORRY, BUT I DON'T UNDERSTAND "FRONT". CAN YOU USE "RIGHT", "LEFT", ETC.?

use left for front

OKAY. BY "FIRST" INPUT I WILL ASSUME YOU MEAN "TOPMOST". NOW I'M
 CONFUSED: HOW CAN I PUT A GATE I[N]?
 CONFUSED: HOW CAN I PUT A GATE ITO THE LEFT OF TWO DIFFERENT PLACES?

well. [pultry using two not gates.

OMKAY. IS THIS WHAT YOU WANT (DRAWING...)?

ok connect this output (pointing...) with this input
 (pointing...)
 <1, 2>

OKAY

[do the same]?
 repeat the operation with the other not gate and its closest and
 gate input.

OKAY

label the output of the bottommost and gate carry

DONE

Now let me draw some more lines...SHALL I TRACE THESE FOR YOU??

what does that mean?

SHALL I INCLUDE THE LINES THAT YOU DREW IN MY PICTURE??

that is what I was assuming.... AOIsOKA,Y [label]?
 that is what I was assuming.... AOIsOKA,Y label this line
 (p[ii]ointing...) P and the one below it Q. <3>

OKJAY...

Now, please redraw the picture so that lines are straintg except
 when the "pass over"
 other linies, and so that there i[n]s a uniform progression from left
 to right (i.e. there are no ["backwards"]?
 to right (i.e. there are no lines going "backwards")

I DON'T KNOW [AH]?

I DON'T KNOW WHAT YOU MEAN BY BACKWARDS, BUT LET TRY THI[O]?

I DON'T KNOW WHAT YOU MEAN BY BACKWARDS, BUT LET TRY THIS...

REMARK command Used 0:00:04.9 in 1:04:20, Load 14.95

<slide 2>

Gee, that's real pretty!

THANK YOU I GUESS (I DO NOT KNOW WHAT "PRETTY" MEANS)

But, you just redrew the picture "pretty".

IS "PRETTY" THE NAME OF THIS PICTURE, THEN?

No, the name is jake.

GO ON.

Please tell me what the range of inputs and outputs is for this!

Please tell me what the range of inputs and outputs is for jake.

JAKE IS A PICTURE. JAKE DOESN'T HAVE INPUTS AND OUTPUTS.

No, jake is the name of a generic circuit which has manifested itself in a picture we have drawn together.

I DON'T KNOW ABOUT "GENERIC" OR "MANIFESTED". PLEASE RE-ASK YOUR

REMARK command Used 0:00:05.5 in 1:09:44, Load 21.06

I DON'T KNOW ABOUT "GENERIC" OR "MANIFESTED". PLEASE RE-ASK YOUR

I DON'T KNOW ABOUT "GENERIC" OR "MANIFESTED". PLEASE [R]

I DON'T KNOW ABOUT "GENERIC" OR "MANIFESTED". PLEASE RE-ASK YOUR QUESTION.

The picture we have drawn is a connected set of logic gates with inputs and outputs. right?

WHATEVER YOU SAY.

Do you know what an and gate does?

Y

Protocol between user H and system person Q. Continuation of previous protocol. User began typing at 8:45am. Session ended at approximately 10:30 am. There was some discussion between user and system person of a general sort (How are you doing, I don't understand how to design this thing, what do you think of that command type interactions. However, all instructions were given only in typed form). Both user and system person reviewed the previous protocol to familiarize themselves with what had happened. The user, in addition, reviewed the task instructions.

 TELNET logging file started at Wed 14 May 80 0834:44
 on connection 1 from 2 to BBND-30324000050

Do you remember everything that we were talking about the last time I visited you?

[yes]YES

DI lo you know what an AND gate does?

YES. WOULD YOU LIKE ME TO GIVE YOU THE TRUTHJ TABLE FOR "AND"?
 AN AND GATE COMPUTES THAT TRUTH FUNCTION ELECTRONICAL[;L]LLY%

YES. WOULD YOU LIKE ME TO GIVE YOU THE TRUTHJ TABLE FOR "AND"?
 AN AND GATE COMPUTES THAT TRUTH FUNCTION ELECTRONICALLY.

Well, no, but can you compute the truth t[h]able for jake?

YES. HOLD ON...

HERE IS THE TRUTH TABLE:

P	Q	SUM	CARRY
0	0	0	0
0	1	1	0
1	0	1	[]%
1	0	1	0
1	1	[]%	
1	1	0	[]%
1	1	0	%
1	1	0	[]%
1	1	0	1

Please remember this [b]input and output behaviour -- you might need it later. Do you [u]now understand what the circuit (jake) does?

- 1) I WILL REMEMBER THE B[AHA]%
- 1) I WILL REMEMBER THE BEHAVIOUR YU REQUEST[Y].
- 2) THE CIRCUIT COMPUTES THE TRUTH FUNCTION IN THE TABLE I JUST PRESENTED TO YOU.

fine. now let's use this information and circuit to make a parallel 4-bit binary adder.

OKAY.

Package Jake into a little box, and draw me a new picture, not labelling the inputs and outputs, down the left side of the screen.

COME AGAIN!
COME AGAIN?

WHAT DO YOU MEAN BY "PACKAGE JAKE INTO A LITTLE BOX"? FOR AIRMAILING??

I want to [ass]hide the contents of jake. I'll show you what i mean... The contents of the box I just drew that is labelled Jake is an instance of the circuit we just designed a little while ago. OK?

OK. IN YOUR LAST REQUEST, MAY I ASSUME THAT BY "A NEW PICTURE" YOU MEAN A NEW PICTURE OF JAKE?

ALSO, JOHN, I AM NOT SURE WHAT YOU MEAN BY "DOWN THE LEFT SIDE OF THE SCREEN"

Well, let me show you what I mean[,]. Please erase the top part of the screen.

<slide 3>

OKAY...

Put a copy of Jake [()<pointing> making it a little smaller. <1>

ASSUMING: A COPY[T]
ASSUMING: A COPY OF THE PICTURE OF JAKE WITHOUT SHOWING THE LOGIC GATES;
ALSO, "HERE" IMPL[OL]
ALSO, "HERE" IMPLIED BY YOUR POINTING...

Put another copy below that one.

OKAY...

Label the two inputs to the top one P1 and Q1

OKAY...

And label its outputs S1 and C1

DONE

^B

Put another Jake below the second one
Put another Jake below the second one, please.

OK[L]
OKAY...

Label the <line erased with control-u>
Connect c1 with <pointing>. <2>

DONE

connect s2 with <pointing>[/1...o

Break in log file due to someone tripping over a cord!

TELNET logging file started at Wed 14 May 80 0941:55
on connection 1 from 2 to BBND-30324000104

connect s1 with <pointing>... <3>

done

relabel q1 to be p2

OKAY...

Label <pointing> p3 <4>

DONE

Label <pointing> carry <5>

DONE[R]

rela <whole line earsed with control-u>
Move p3 to <pointing>... <6>

DO YOU ME[N]AN T[HGE]s
DO YOU MEAN THE LABEL "P3"?

yes

DONE

Label <pointing> sum <7>

DONE

connect <pointing> with [p]<pointing> <8> <9>

DONE

could you tell me the truth table for the circuit...

WAIT[/]...

INPUTS	O[P]UTPUTS
INPUTS	OUTPUTS

P1	P2	P3	S1	C1	CARRY	SUM
0	[0]	1				
0	0	0	0	0	0	0
0	0	1	0	0	1	0
0	1	0	1	0	1	0
0	1	1	1	0	0	1
1	0	0	1	0	1	0
1	0	1	1	0	0	1
1	1	0	0	1	1	0
1	1					
1	1	[1]				
1	1	1	1			
1	1	1	0	1	0	0

DONE

Turn the middle Ja

Turn the second Jake into an OR gate, keeping the labels the same.

<slide 4>

OKAY... JOHN, I HAVE A PROBLEM. IN TURNING THE MIDDLE JAKE INTO AN OR GATE, I HAVE TWO OUTPUTS FROM THE JAKE, AND I AM ONLY ALLOWED ONE FROM THE OR GATE. DO YOU WISH TO ASSIGN ONE OF THE OUTPUTS OF THE JAKE TO BE THE ONE AND [N]

OKAY... JOHN, I HAVE A PROBLEM. IN TURNING THE MIDDLE JAKE INTO AN OR GATE, I HAVE TWO OUTPUTS FROM THE JAKE, AND I AM ONLY ALLOWED ONE FROM THE OR GATE. DO YOU WISH TO ASSIGN ONE OF THE OUTPUTS OF THE JAKE TO BE THE ONE AND ONLY ONE FROM THE OR?

Yes, the one labelled Carry

OKAY...

remove the label sum <sum appeared below the point #1>

OKAY...

remove the connection between <pointing> and <pointing> <1> <2>

OKAlabeYl <

P
o
o

label <pointing> sum; connect <pointing> with <pointing>, and

display the truth table again -- carry and sum are all you need
to tell me about. <1> <2> <3>

OKAY...

P1	P2	P3	SUM	CARRY
0	0	0	0	0

P1	P2	P3	SUM	CARRY
0	0	1	1	0
0	1	0	1	0
0	1	1	0	1
1	0	1	0	1
1	0	0	1	0
1	0	1	1	1
1	0	1	0	1
1	1	0	0	1
1	1	1	1	1

DONE

Now, package up that [c] and call it Crab

BY "THAT"[:] YOU MEAN THE SET OF GATES/JAKES AT THE TOP OF THE DISPLAY?

yes

OKAY...

now, clear the screen

<slide 6>

OKAY

put a1 in instance of jake at the top of the screen

DONE

put an instance of crab below it

OK

label the two inputs to the instance of jake p1 and q1

OK

label the top output of the instance of jake s1

OK

connect <pointing> with <pointing> <1> <2>

OK

label the other two inputs of the instance of crab p2 and q2

OK

label the bottom output of the instance of crab s2 and display another instance of crab below the one displayed.

OK

Label the bottom two inputs [ilof <pointing> p3 and [p4]q3 <3>

OK

on <whole line earsed with control-u>
connect <pointing> with <pointing> <4> <5>

DONE

label <pointing> s3 <6>

DONE

give me another instance of crab below the bottommost one.

OK

connect <pointing> with <pointing> <7> <8>

OK

label <pointing> s4 and <pointing> carry <9> <10>

OK

label the last two inputs p4 and q4

OK

What c[alrabs do is add three binary numbers together producing a sum and a carry. What we just [drew]%
What crabs do is add three binary numbers together producing a sum and a carry. What we just designed I hope takes 2 4-bit binary nu[blmbers and produces a 5-bit sum .

OH.

you don't find that interesting?

I DON'T KNOW [A]%

I DON'T KNOW WHAT IT MEANS.

do you know about addition?

NO.

BYE.

bye, gye!

4. PRELIMINARY PROTOCOLS USING TASK TWO

4.1 Preliminary Protocol One

4.1.1 Transcript 1

TELNET logging file started at Wed 26 Mar 80 1019:31
on connection 1 from 2 to BBND-30324000142

SLIDE 1 OF SLIDES

hi, I am going to (wh deleted) show you what a 1 bit adder looks like. First of all, the adder has 2 and gates, 1 or gate and 1 not gate. start out by (b deleted) putting an (an deleted and then line back to "the adder has..")

the adder has 2 and gates, 1 or gate and 1 not gate. start out by putting an AND gate at the top of the screen.

OK. This is an AND gate.

No, it's not.

Oh? Thaty is what I thought it was

An AND gate if a half circle and and OR gate is a triangle.

OK. We will use your convention. I (space + s deleted) Is this OK?
<erased picture on slide 1>

yes, fine. Now make the inputs to the AND gate A and B.

Good. Now put an OR gate below and AND gate. Orient (line deleted by rubouts) oops, I mean put an OR gate below (!) the AND gate. O rient it in the same direction as the AND gate is.

Goo. Now this part is hard to explain, so listen caref (y deleted)ully. Connect the inputs of the OR gate to the A and B of the AND gate. What I want is to hav e A acting as input both to the AND and to the OR. The same thing holds for B.

Yes, that was hard to explain. Parsing....
Failure to parse. Could you be more explicit in shorter instructions?

OK. First what didn't make sense?

Your previous input.

Turkey. Ok, here goes. Take the line labeled A and draw a line (co deleted) from it to the first line going into the OR gate. Got that?

Is this ok?

That's okay, but now you should erase the A label and put the label on to the left of the new line.

Just a moment please. Is this what you wanted?
<slide 2>

That's okay. Now take the line that used to be labelled <line deleted> Tha's okay. now (ea deleted) erase the B and extend the line that was labeel d B to the left about 2 inches. Re-label it B.

Drawing...how is this?
<slide 3>

Fine. Now extend a line down from about the middle of the B line to the line on the OR gate that has no input.

OK

No, not quite what I want. I (l deleted)'ll point to the place on the line... (Go deleted) Draw from here to the input.

I'm sorry. Is this better?
<slide 4>

great.. Before we go any further, please label the AND and OR gates.

What sort of labels do you want?

AND and OR respectively.

Good. Now, extend the output of the AND gate to here. (label 1)

OK

Now draw a line between here and there. (labels are 2 and 3)

OK

Put a NOT gate at the end of the line and label it NOT.

OK

Good. Put an OR gate here. (label 4)

ok

Good. Hook up it's input to the N (o deleted)OT (the top input of the OR) and to (delete of "and to" via control-w) and hook the output of this OR to the input here. (5 and 6 labels)

OK?

We are almost done. Label the unlabelled OR gate OR; The label the output of the AND gate C (a deleted)ARRY, and label the output of the OR gate SUM.

I assume you meant the last OR gate 's output was the one you wantede labeled. Is this alright?

yes. However, I goofed! The last or (G deleted) gate should have beern an AND gate. Please change it to (and deleted) AND gate.

OK
<slide 5>

Almost done. Change the label of OR on the AND gate to AND.

Relabelling...OK
<slide 6>

Well, now you have a 1 bit adder. For future purposes, when I say draw a 1 bit adder, you can draw one of these. Just to make it slightly nicer to look at, erase the A label, draw a line fom here (1) (a deleted) to here (2) and put the label A here (3)

One moment please...Done
<slide 7>

nope. You forgot the A lebel.

Oops! Here it is.

Fine. We're done.

OK. Thanks (for deleted) you.

TELNET logging file started at Wed 26 Mar 80 1133:24
on connection 1 from 2 to BBND-30324000020

<slide 8>
Good morning.

Hi. I am going to show you what a 4 bit adder looks like. You know about 1 bit adders. From now on, I will call (4 deleted)1

bit adders "sum boxes". When you draw a sum box on the screen, you can either draw all the And and OR gates (inside of deleted) of a sum box, you if you want, you can just represent ita (deleted from "all the And" above) all the AND and OR gates of a sum box, or if you want, you can just draw a sum box as a Box with 2 inputs and 2 outputs. Do you follow me?

Yes, I think so. Let me try to draw it...Is this alright?

yes, always label the box SUM and label the outputs S and C.

Fine. Do you have a preference as to whet (e deleted)her I draw the box or all of the gates?

No, do what you want.

OK. The box is easier to draw so I will use that.

Fine. Now draw 3 more sum boxes. Put them here.(1 , 2, 3 labels)

OK

Put a SUM box here (label 4) and coonect the C label of the top SUM box in the picture to the top input of the new SUM box.

Do you really want the label connected or its associated output line?

I meant to connect the line labelled C. Thanks

Glad to be of help

Now extend this line (label 5) to here (label 6)

OK

4.2 Preliminary Protocol Two

4.2.1 Transcript 2

TELNET logging file started at Thu 27 Mar 80 1054:11
on connection 1 from 2 to BBND-30324000012

<slide 1>

good m ornin (g deleted) g. Set up two inbput, (a deleted) A and B, and two outputs, SUM and CARRY. Put A and B above each other on the left, and (S deleted, then Ca deleted)CARRY above SUM on the right.

What do you mean by "Set up two input"? And how can I put two things each above the other?

Draw two lines, A and B, with A above B, on the left of the screen. Have them te rminate this far across the screen.

(1)

I assume you want A and B to label the lines. I(space deleted)s this correct?

yes. Also, A and B should be horizontal.

OK. Do you want the left or the right termination of the lines to be where you pointed?

The right temination. The left termination (a deleted) can be near the left edge of the scre en.

OK...Is the satisfactory?

yes Now draw similar lines for SUM and CARRY on the right (e deleted)side of the screen. Put S UM (a deleted)below CXARRY, and put the labels near the right edge of the screen.

I assume SUM and C(a deleted)ARRY are the labels...OK?

yes

put an AND gate here

(2)

What orientation would you like for the ANDF gate?

Put the output on the right, and connect it to CARRY

OK?

no, connect the output the the line named CARRY

I'm sorry. In the futu(t deleted)re, do you want the use of labe(s deleted)ls to refer their associated objects (always)?

Yes, unless I say otherwise.

Now connect one input line (the top line of the AND gate) to A

and the other input line to B.

OK

Please make all line straight, and use right angles for bends unless I say other wise.

Do you want the image corrected?

yes

<slide 2>

OK

Now put another AND gate below the first one, and connect its output to SUM.

OK

(Connect deleted) Put a NOT gate here and connect its output to the top (lin deleted) inp(o deleted)ut line of the lower A ND gate.

(1)

OK

Now connect the input of the NOT gate to CARRY right here.

(2)

OK

Put an O(r deleted)R gate right here. Put its output on the right.

OK

Connect its output to the lower (line deleted)inpout line of the AND gate.

OK

Connect the top input line of the OR gate to A right here.

(4)

OK

Connect the other inp(out deleted)ut of the OR gaste to B.

Where would you like it connected?

Here

(5)

OK

Move the lowest horizontal part of B down so that there is a single horizontal line to the lower input of the OR gate.

<^G to halt response> quitting

Move the leftmost line of B down so that it is at the same level as the lower input to the OR gate.

I thought B was only a single line segment. Can you be more specific?

OK, that makes things easier. Move B down (so that it deleted) until it is at the same level as the lower input to the OR gate.

Redrawing...OK
<Slide 3>

I'm done.

Thank you.

Thank you!

Report No. 5128

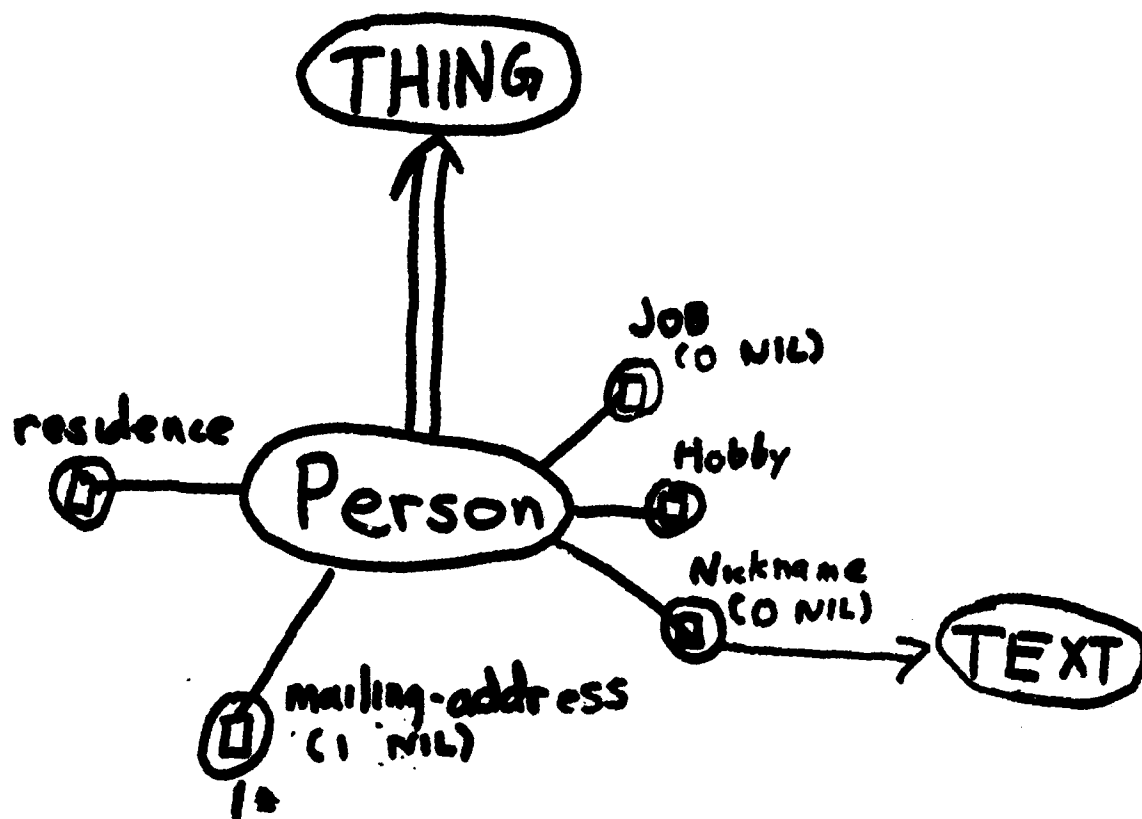
Bolt Beranek and Newman Inc.

APPENDIX A
SLIDES FROM PROTOCOL ONE

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APPENDIX B
SLIDES FROM PROTOCOL TWO

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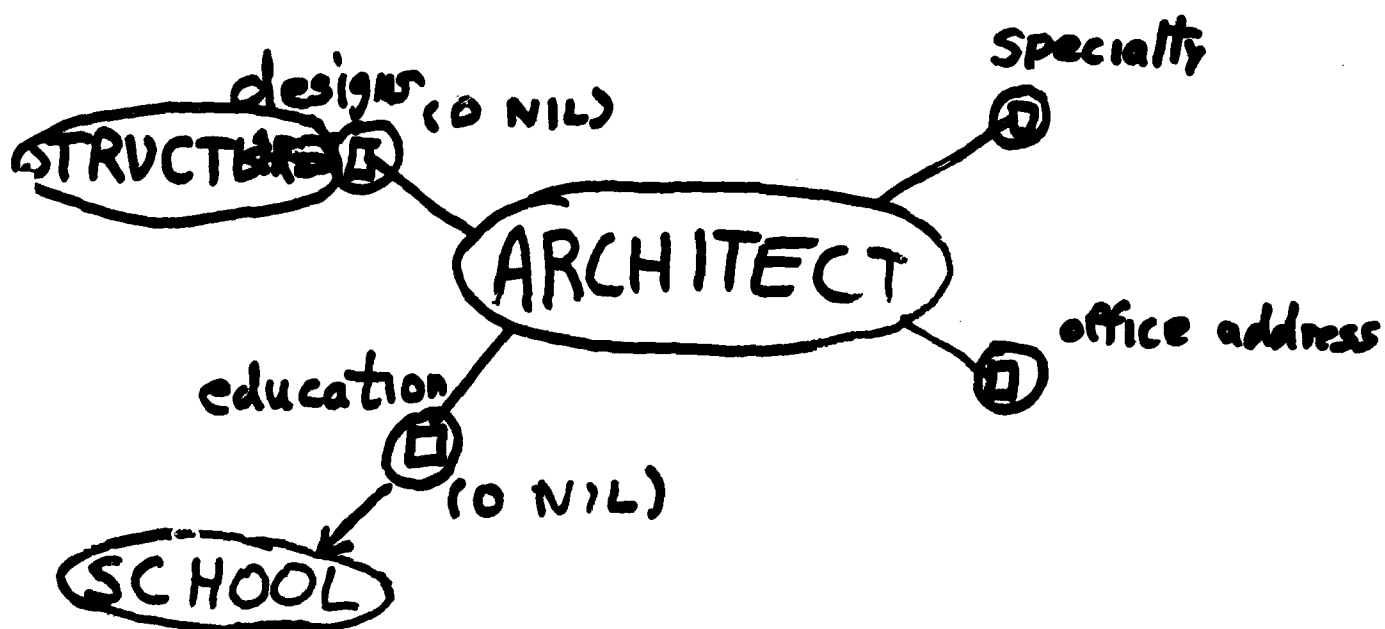


session 2 - 1

2°

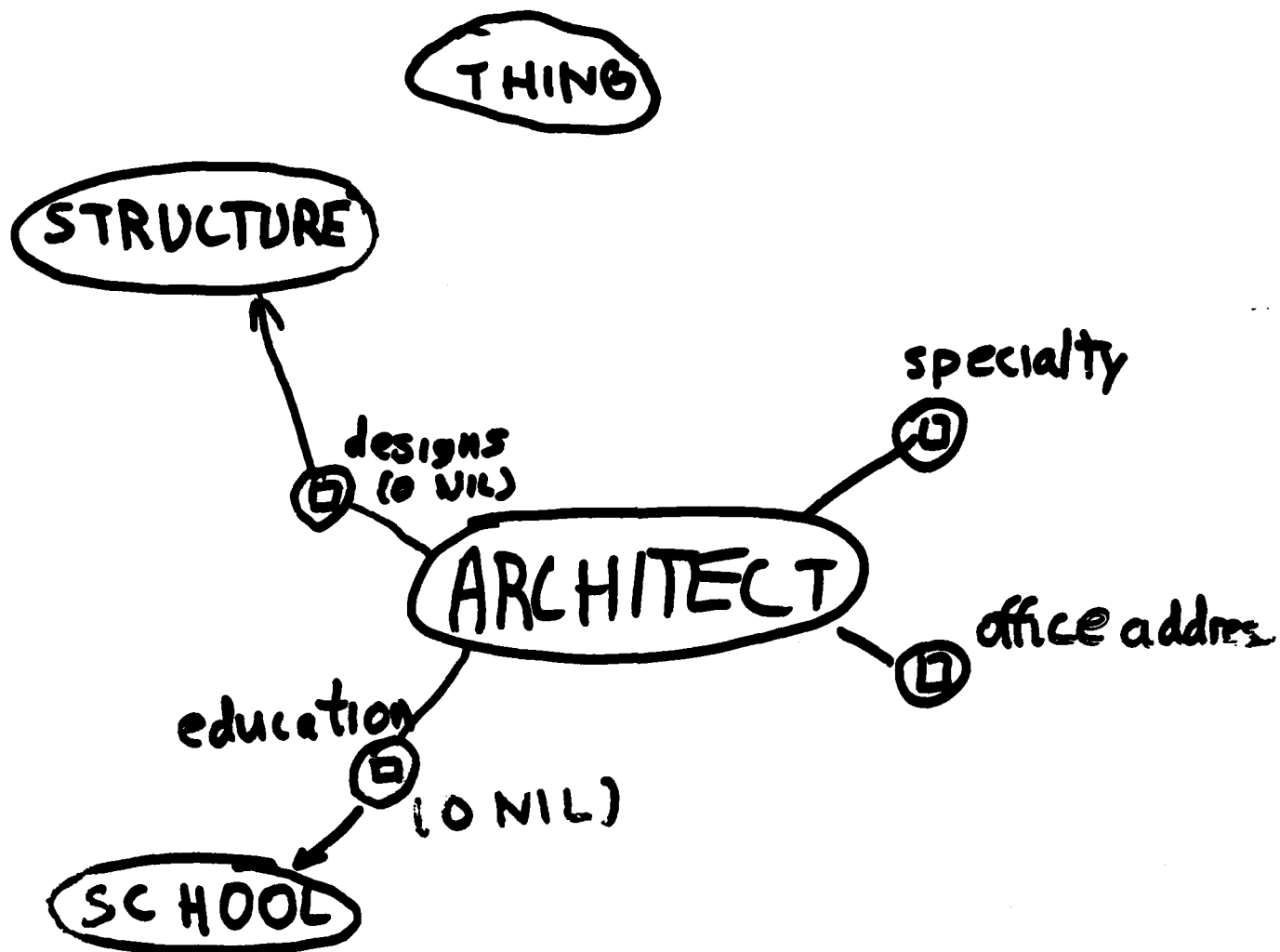
THING

3



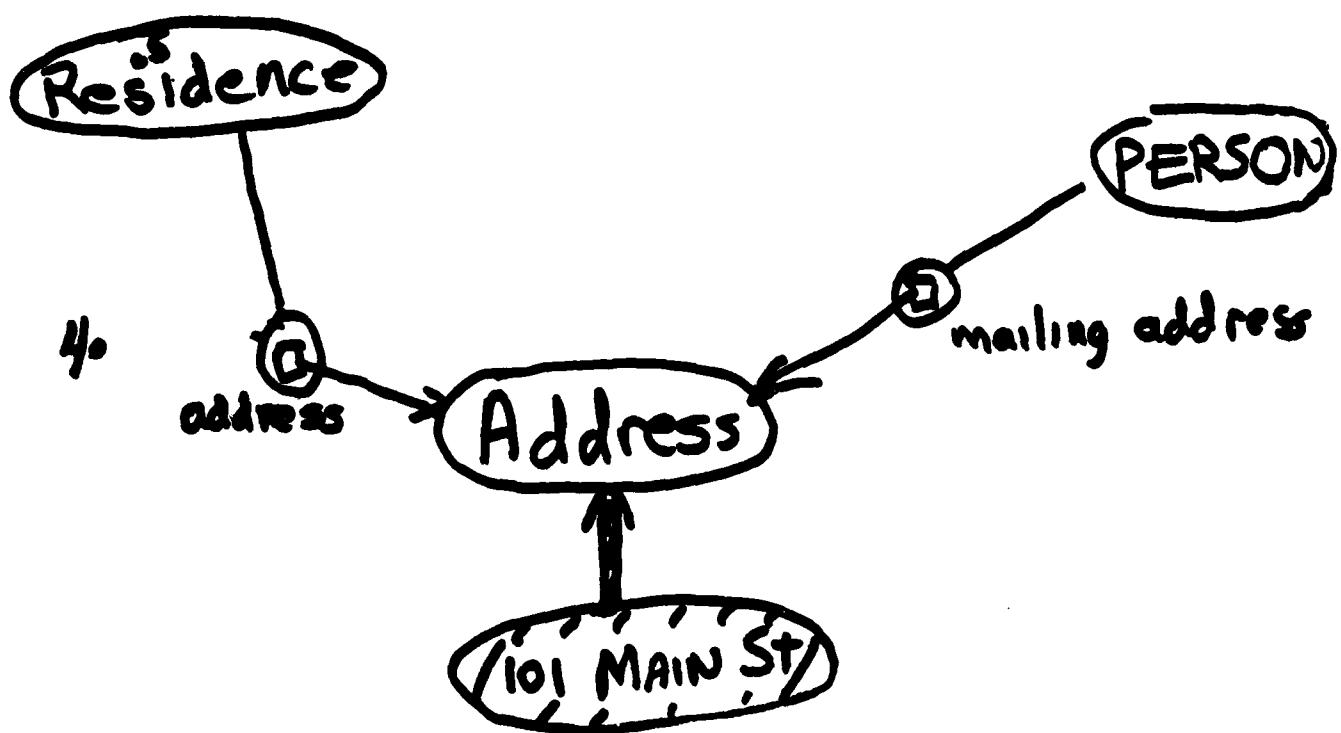
Session 2-2

DISPLAY A



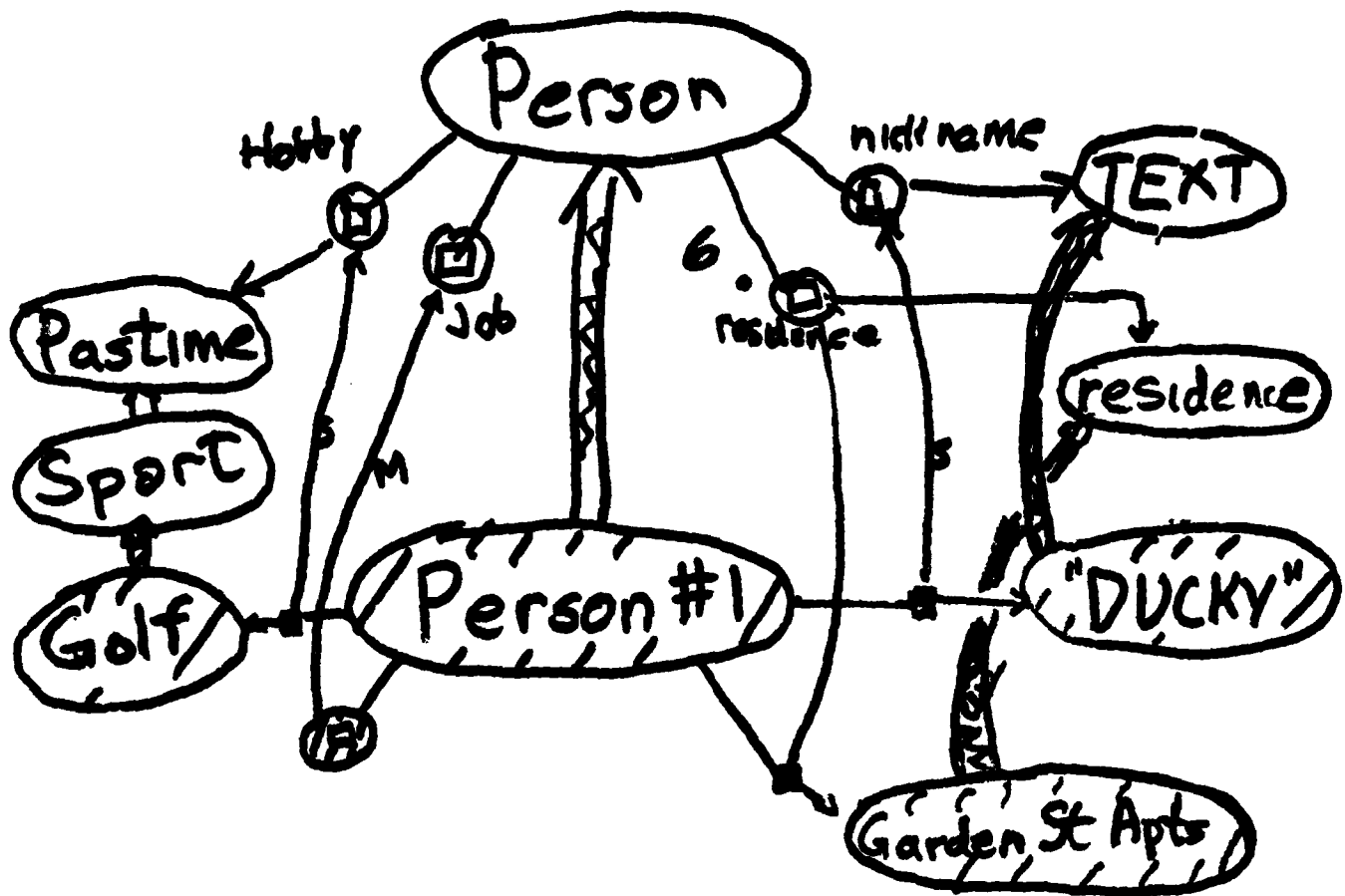
Session 2 - 3

DISPLAY "ADDRESS"

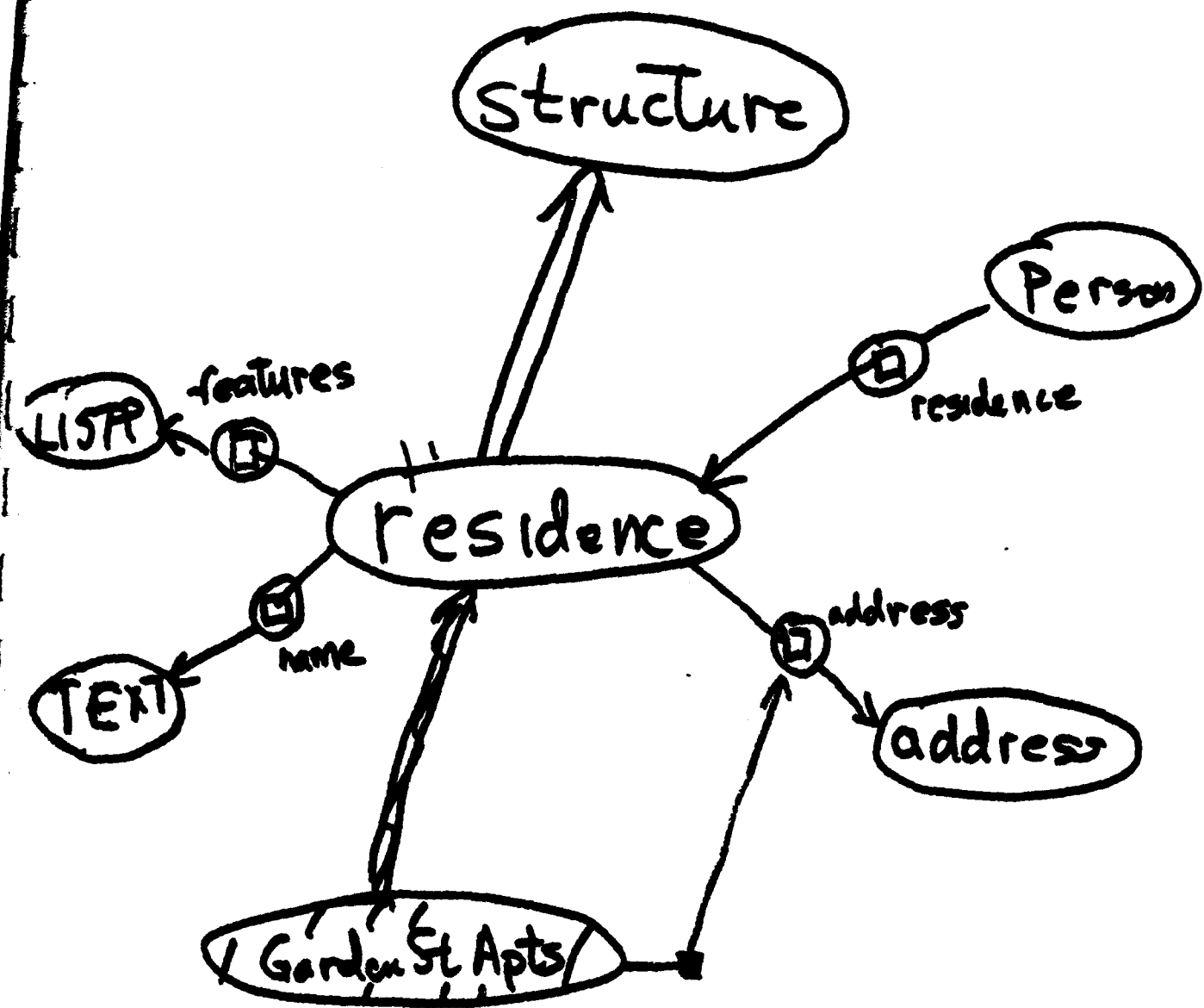


Session 2-4

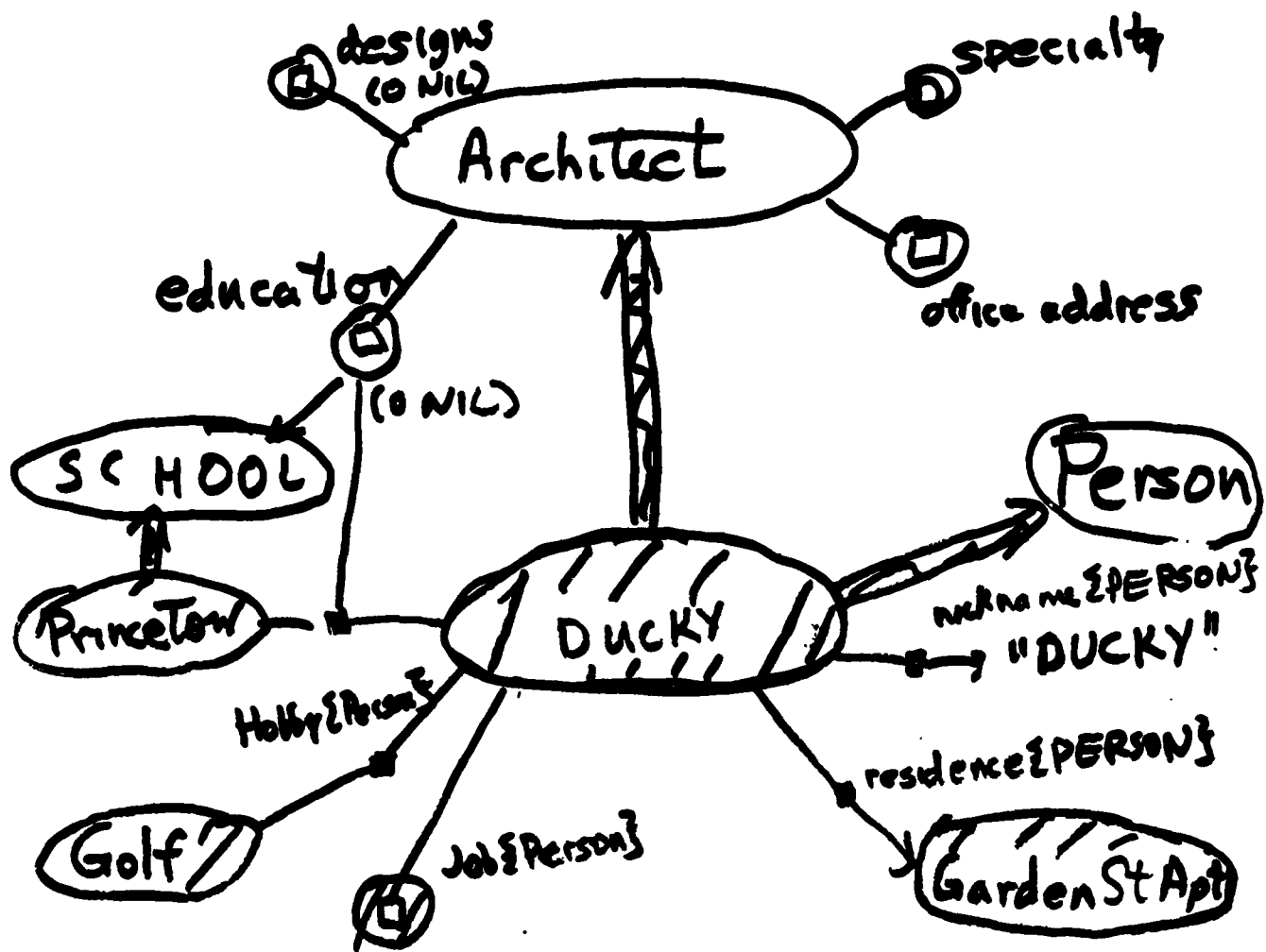
ducky



Session 2-5

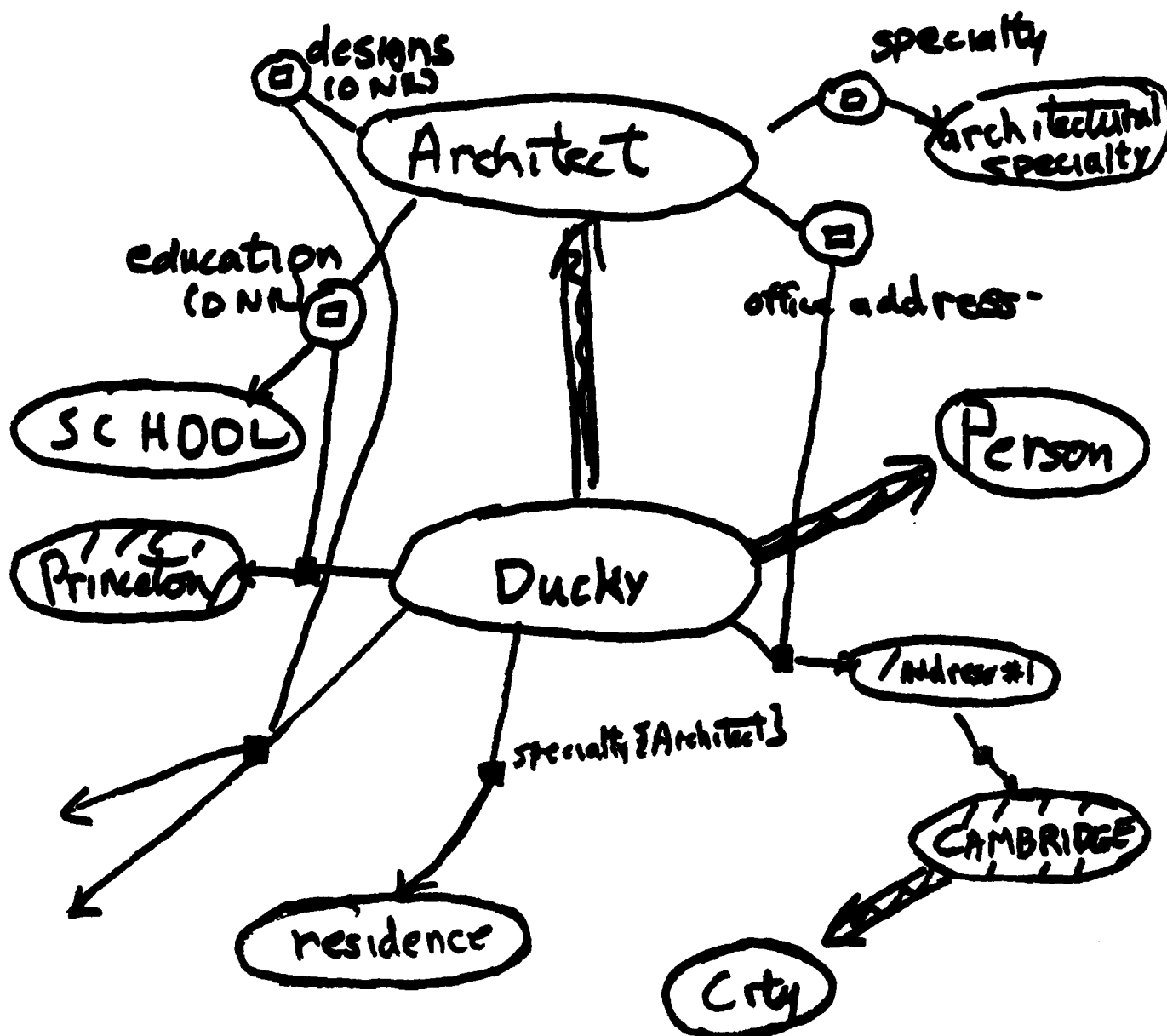


Session 2-6



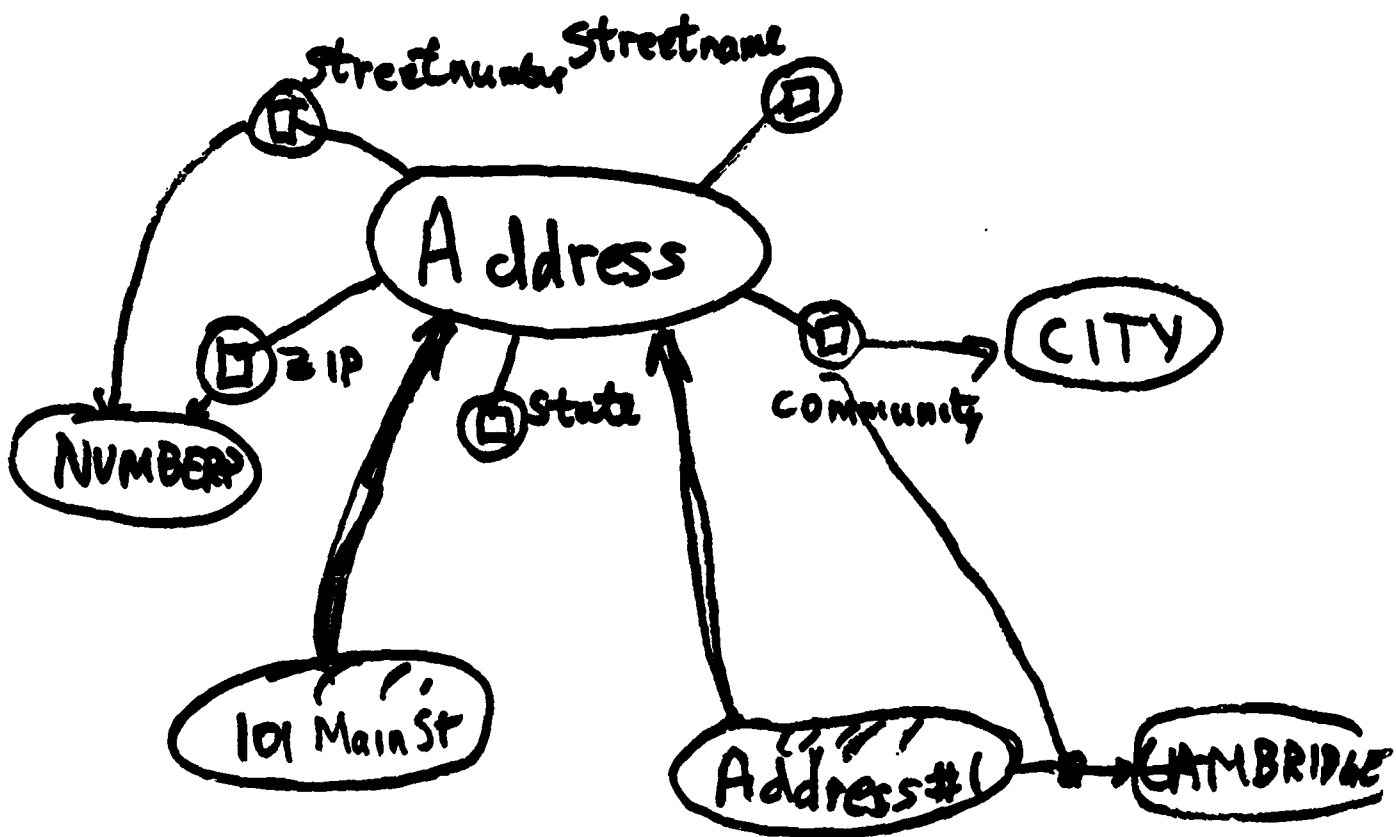
Session 2-7

DISPLAY B



Session 2-8

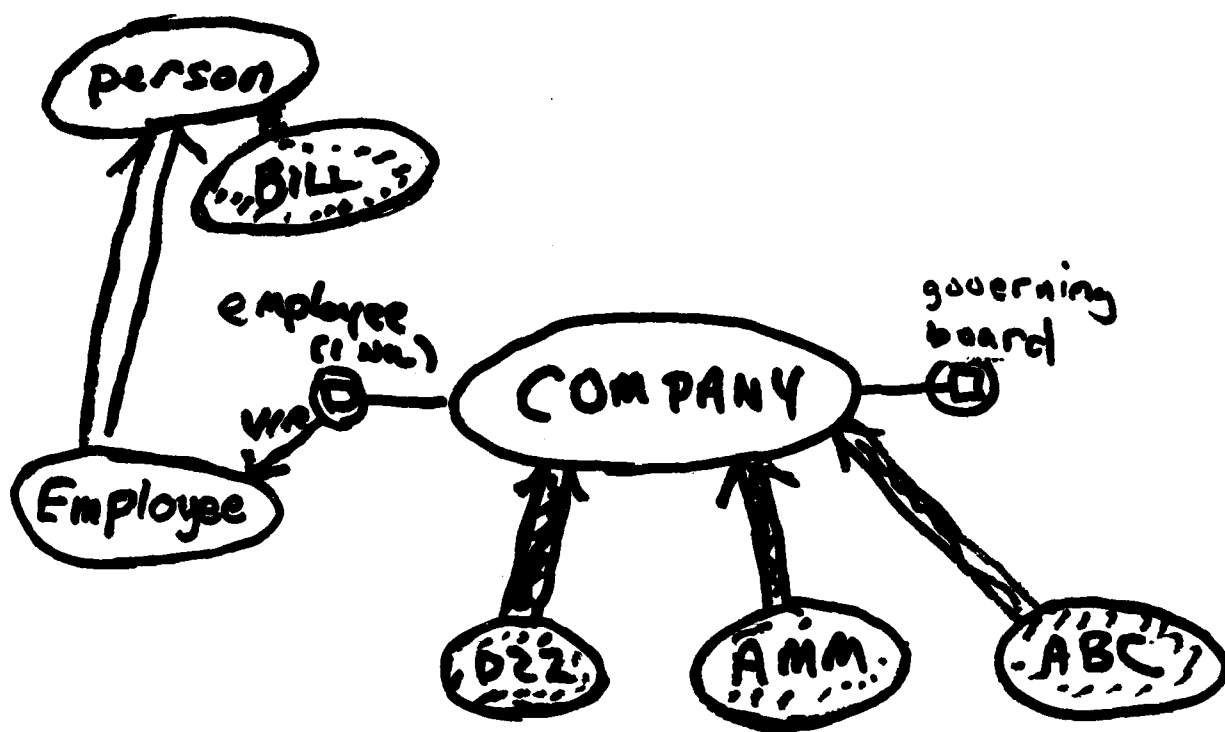
B



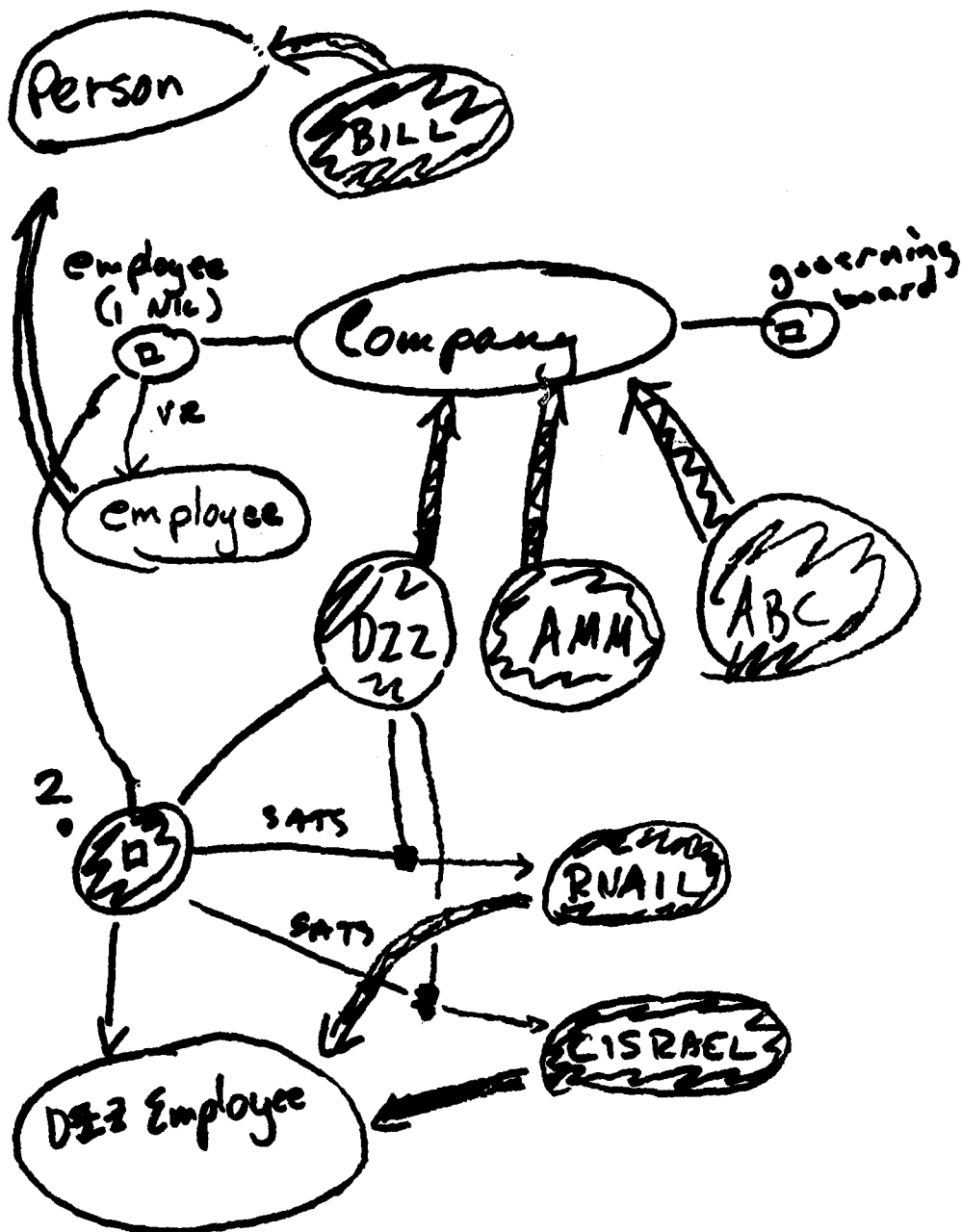
Session 2-9

APPENDIX C
SLIDES FROM PROTOCOL THREE

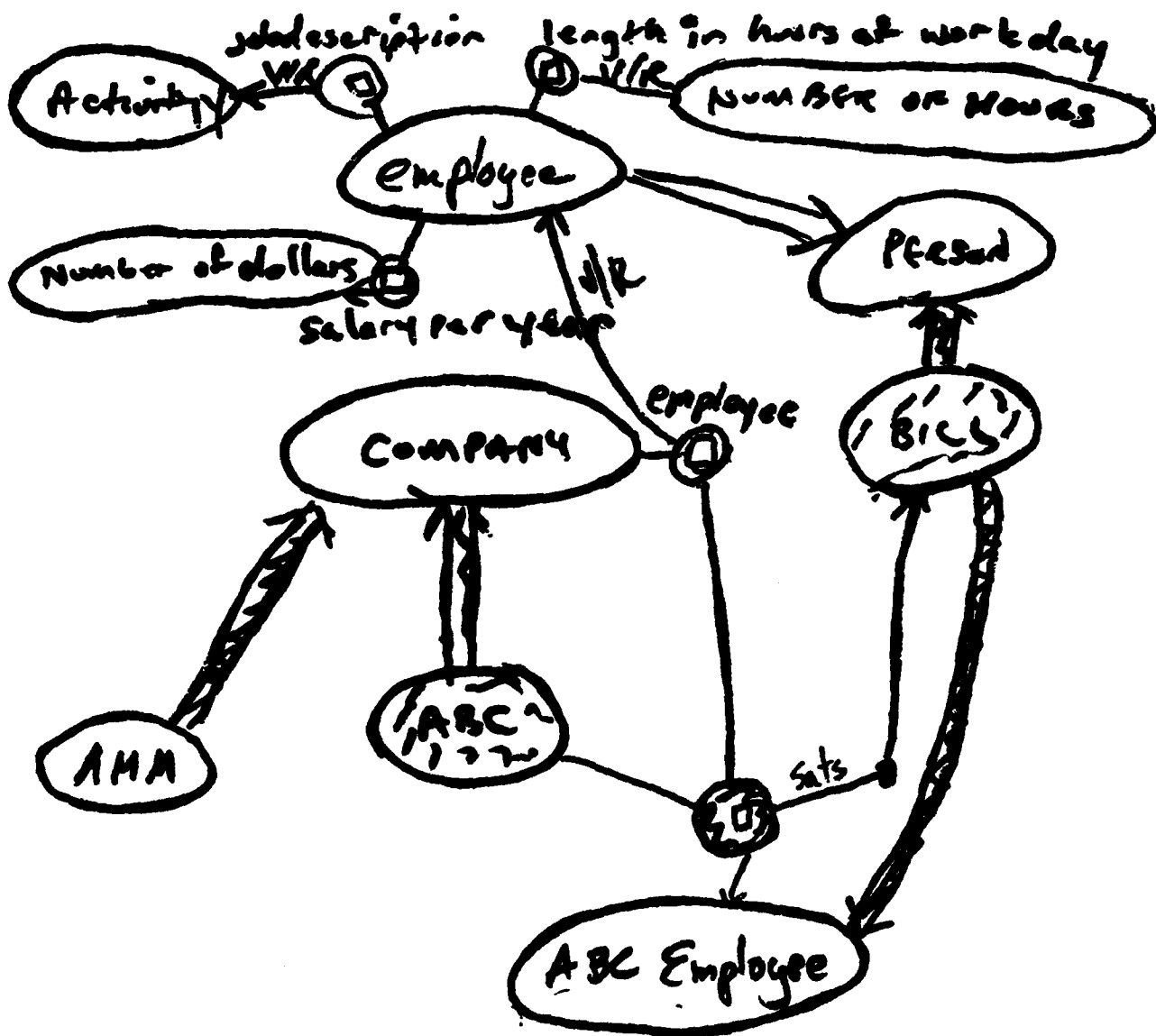
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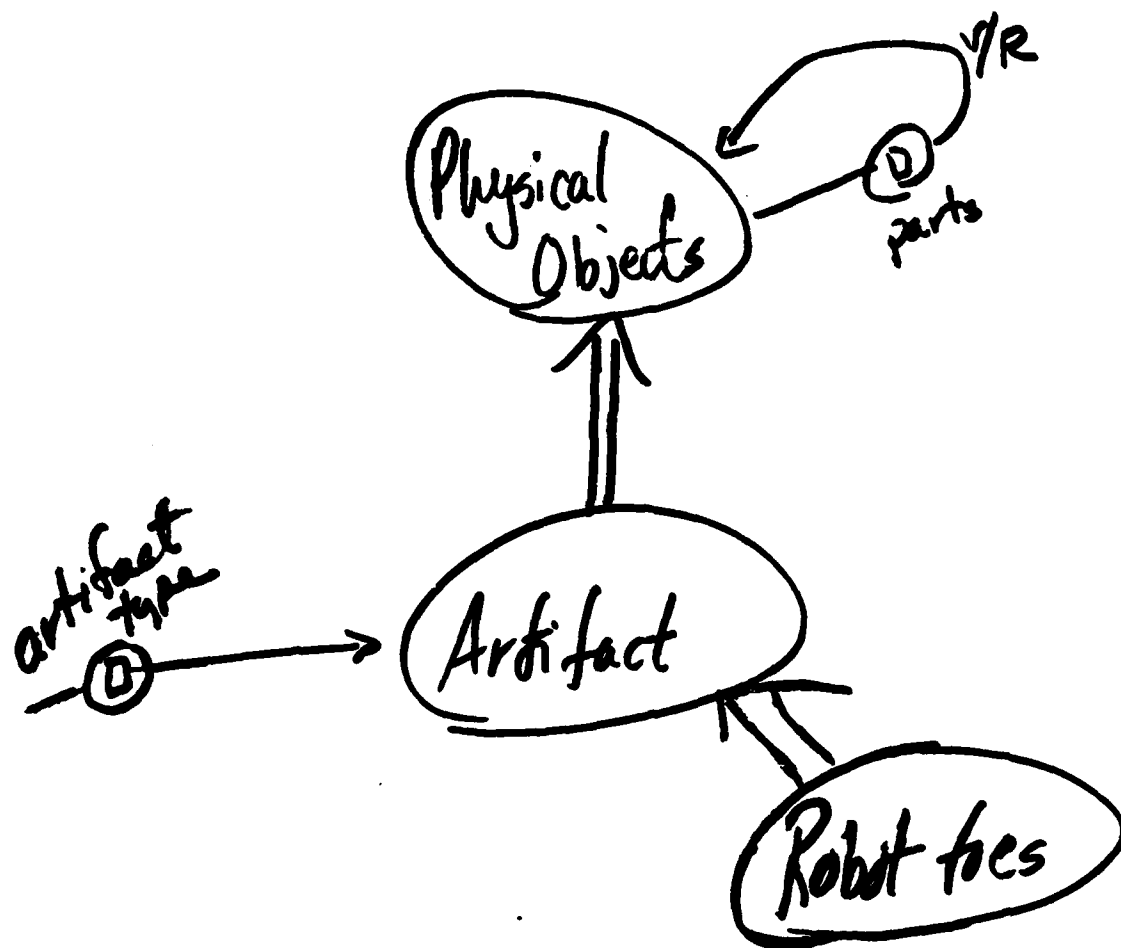
Session 3 - 1



Session 3-2

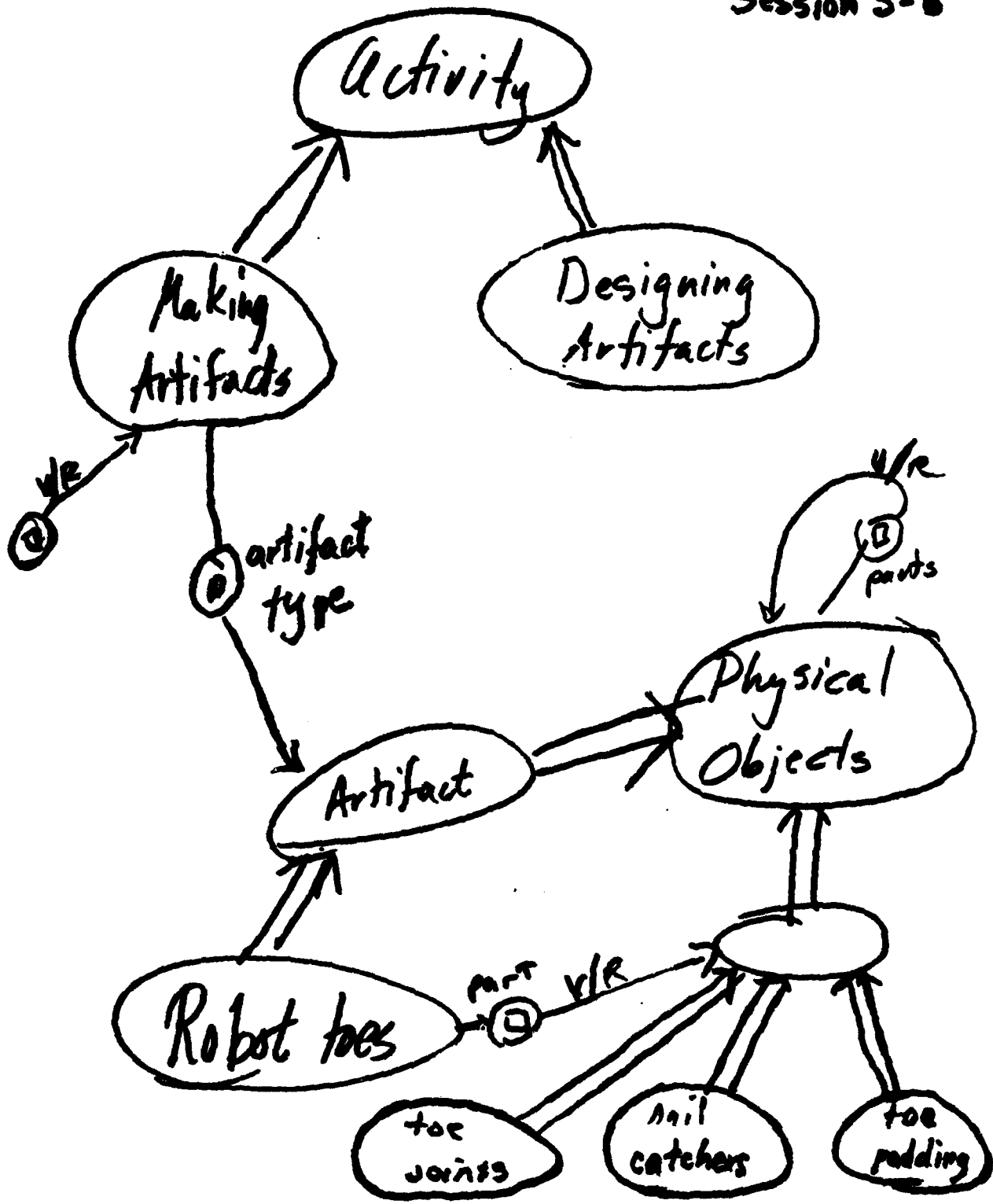


Session 3-3



Session 3-5

Session 3-b



APPENDIX D
SLIDES FROM PROTOCOL FOUR

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AD-A119 762

BOLT BERANEK AND NEWMAN INC CAMBRIDGE MA

F/6 9/2

PROTOCOLS OF USERS MANIPULATING VISUALLY PRESENTED INFORMATION --ETC(U)

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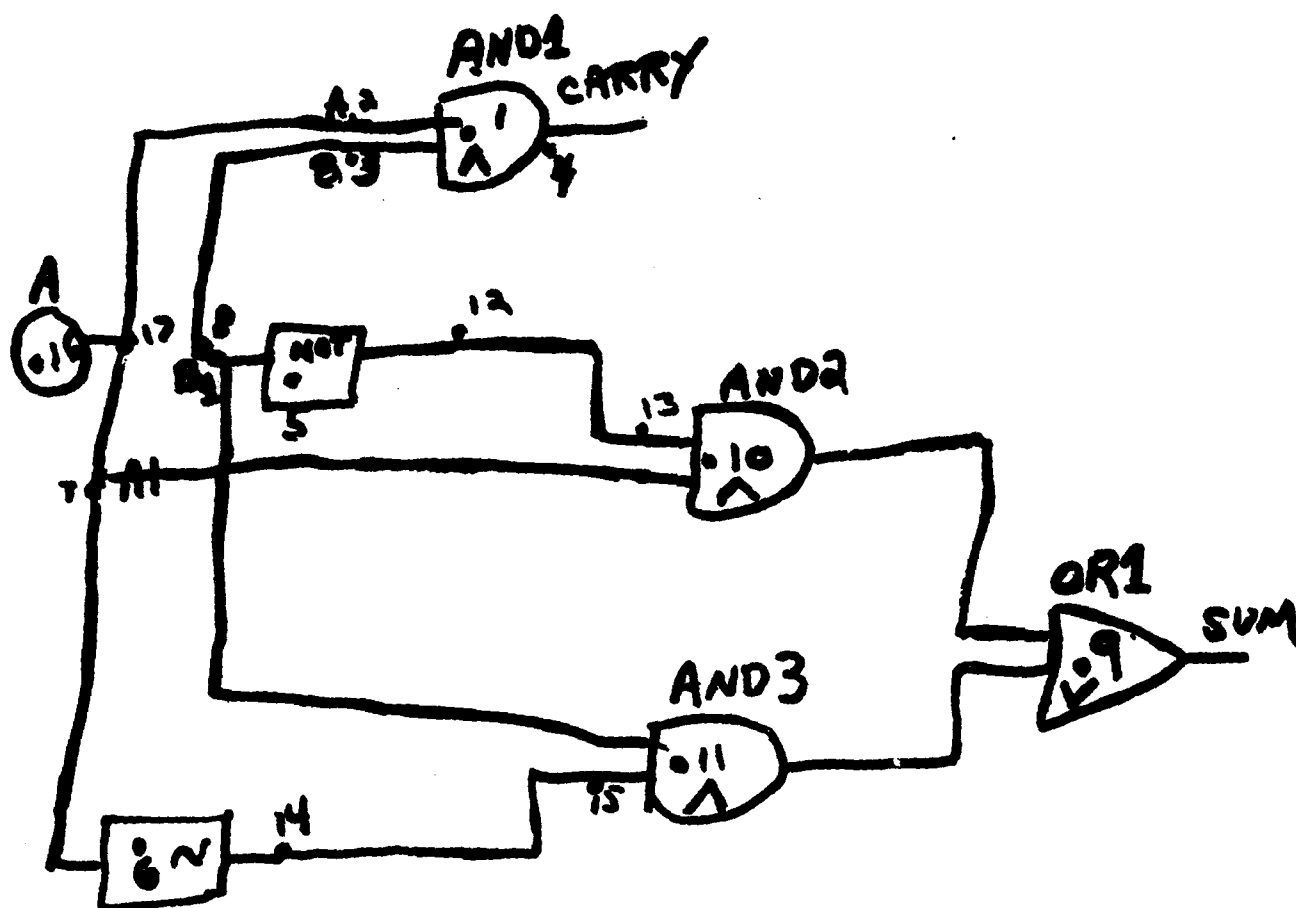
2 of 2

AD A

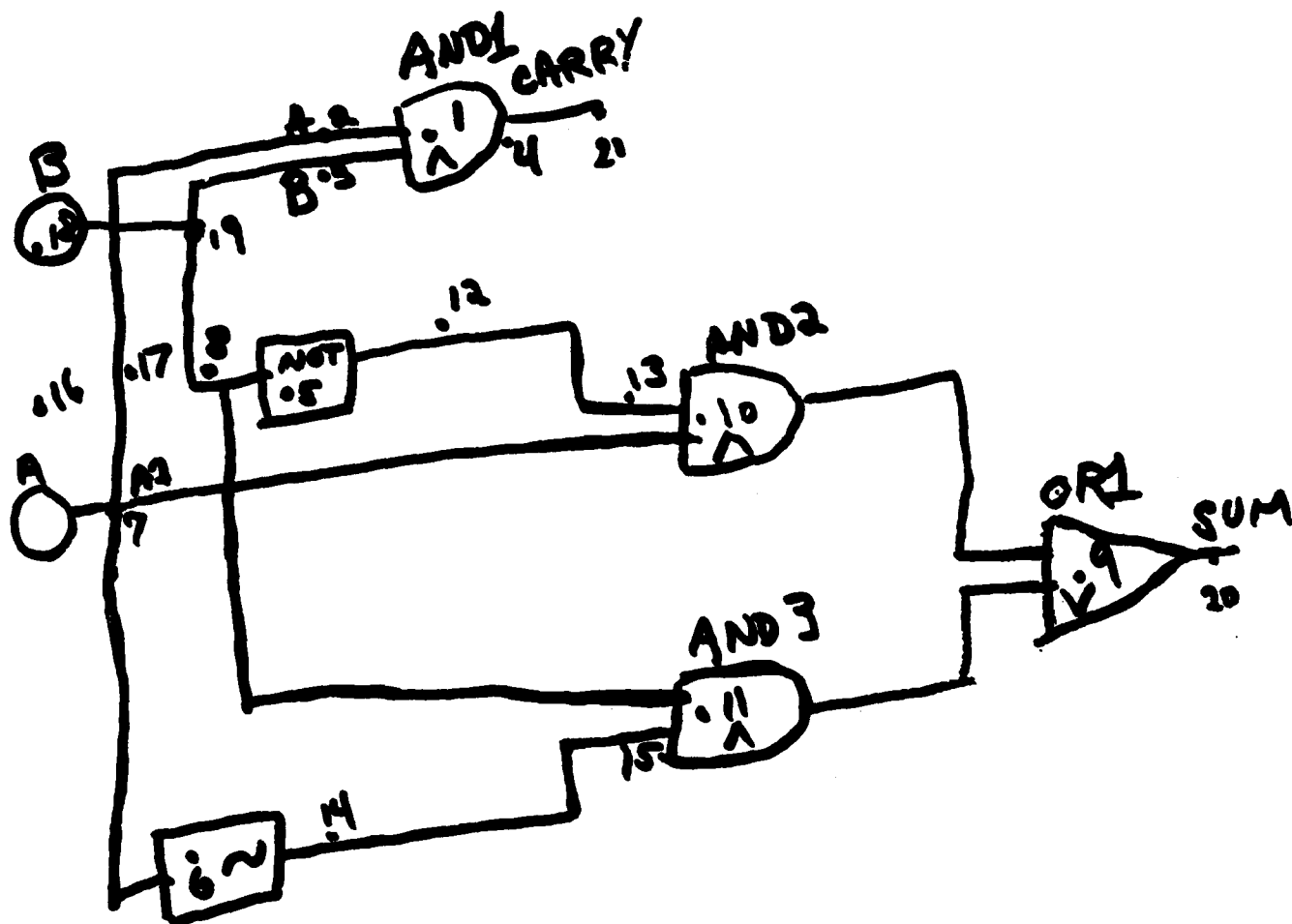
10/14/82



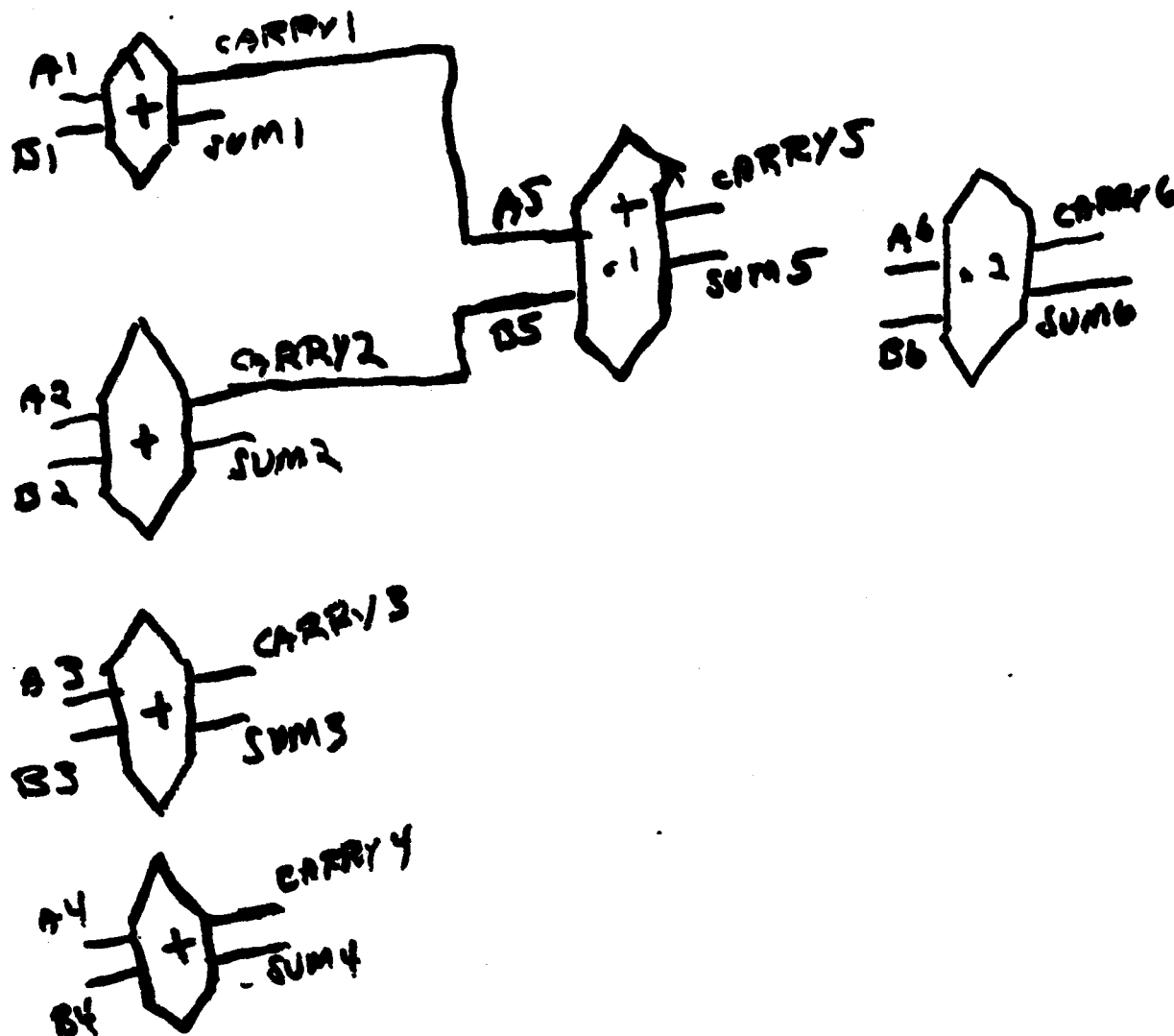
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				PLANT										
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Session 4-1



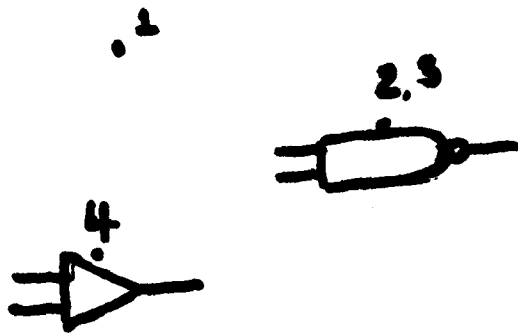
Session 4-2



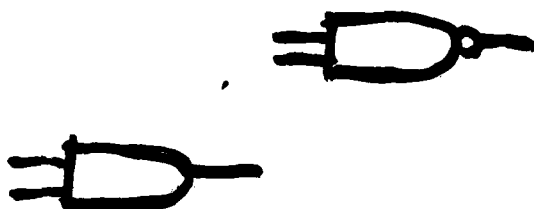
Session 4-3

APPENDIX E
SLIDES FROM PROTOCOL FIVE

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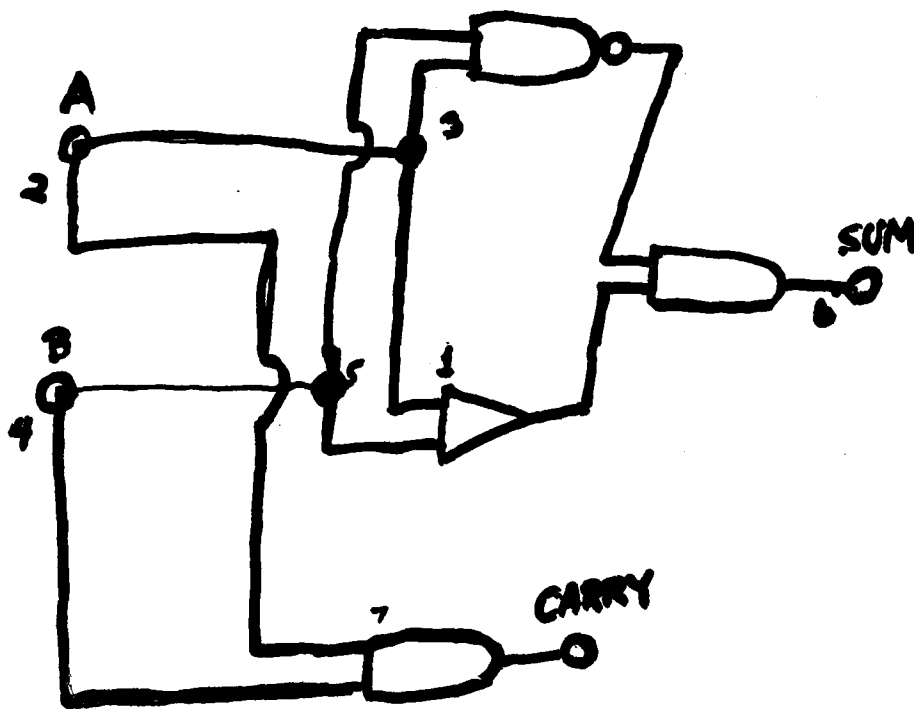


Session 5-1

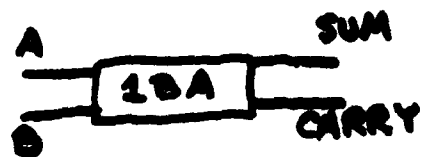


;

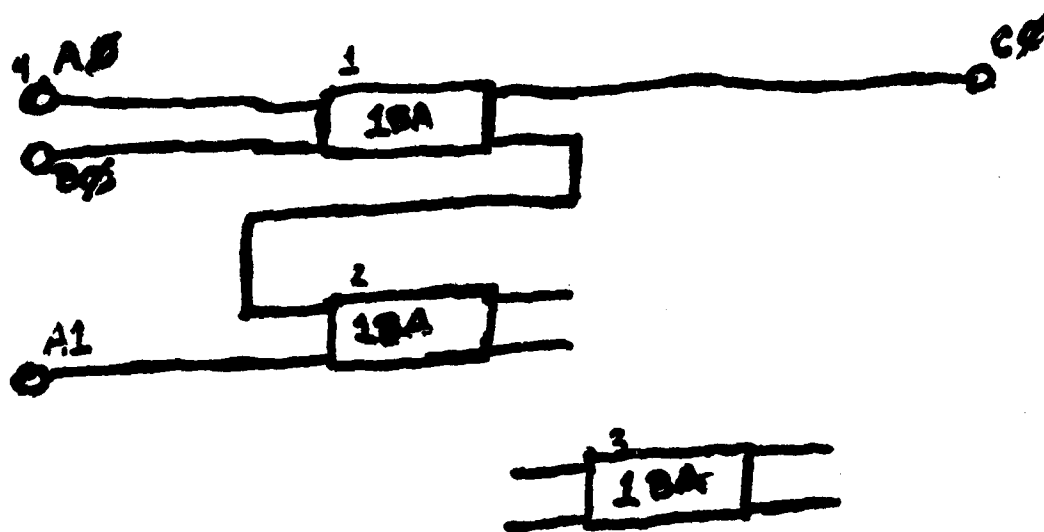
Session 5-2



ONE BIT ADDER



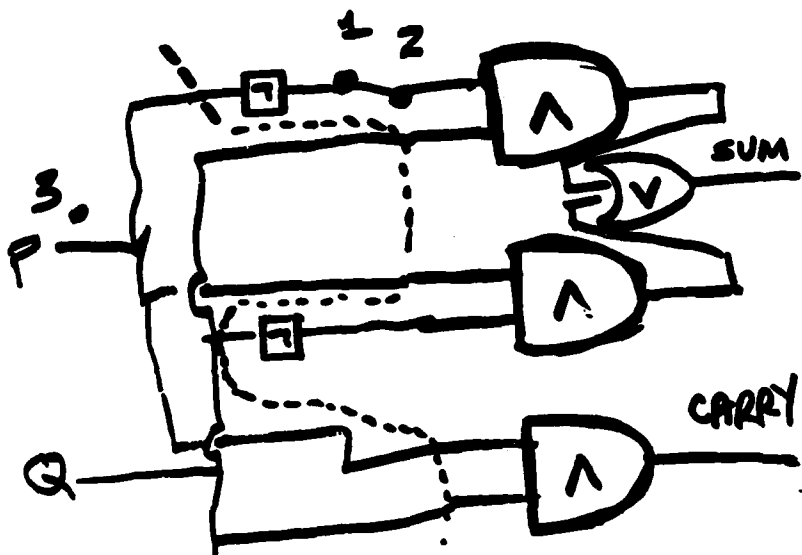
Session 5-3



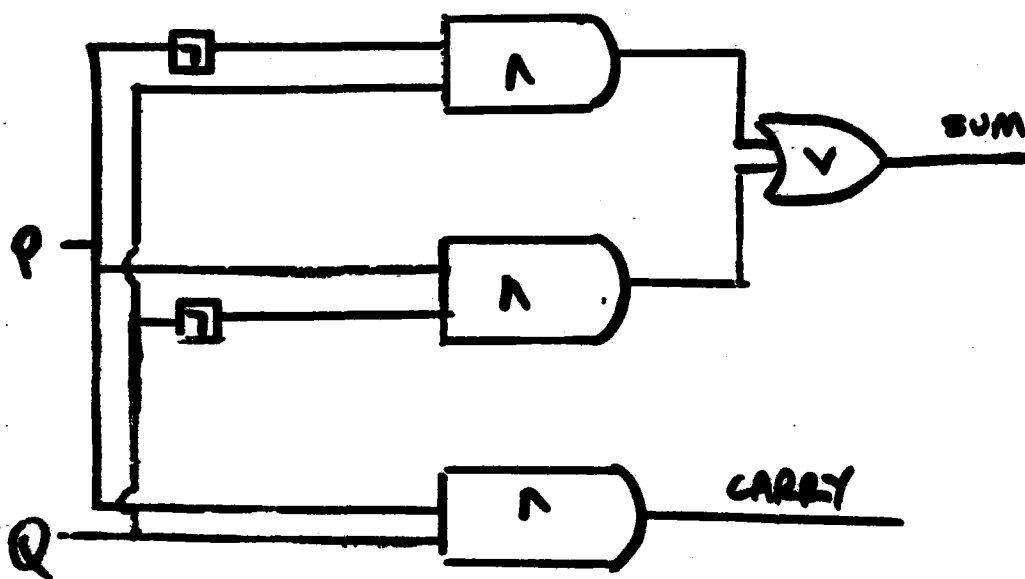
Session 5-4

APPENDIX F
SLIDES FROM PROTOCOL SIX

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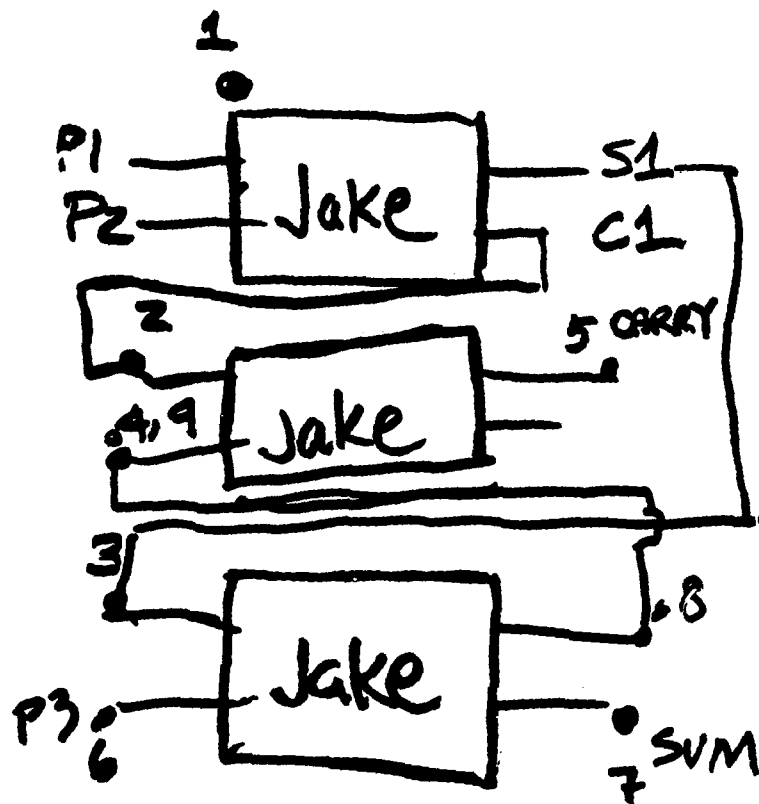


lines drawn by user
Session 6-1

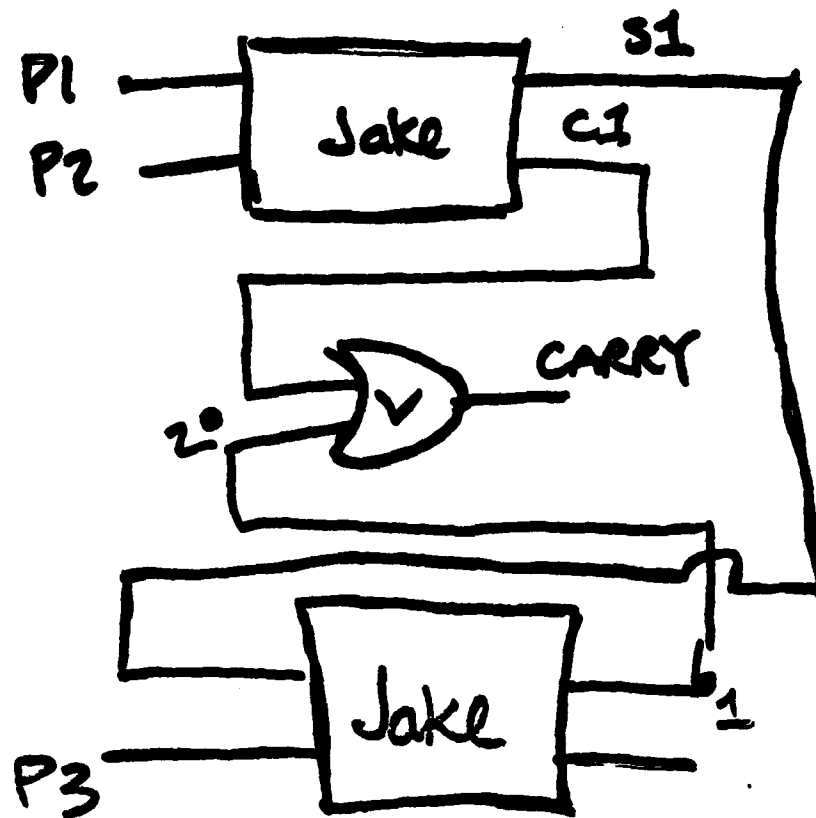


Jake

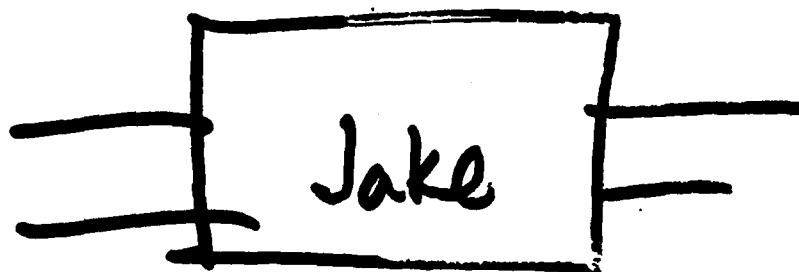
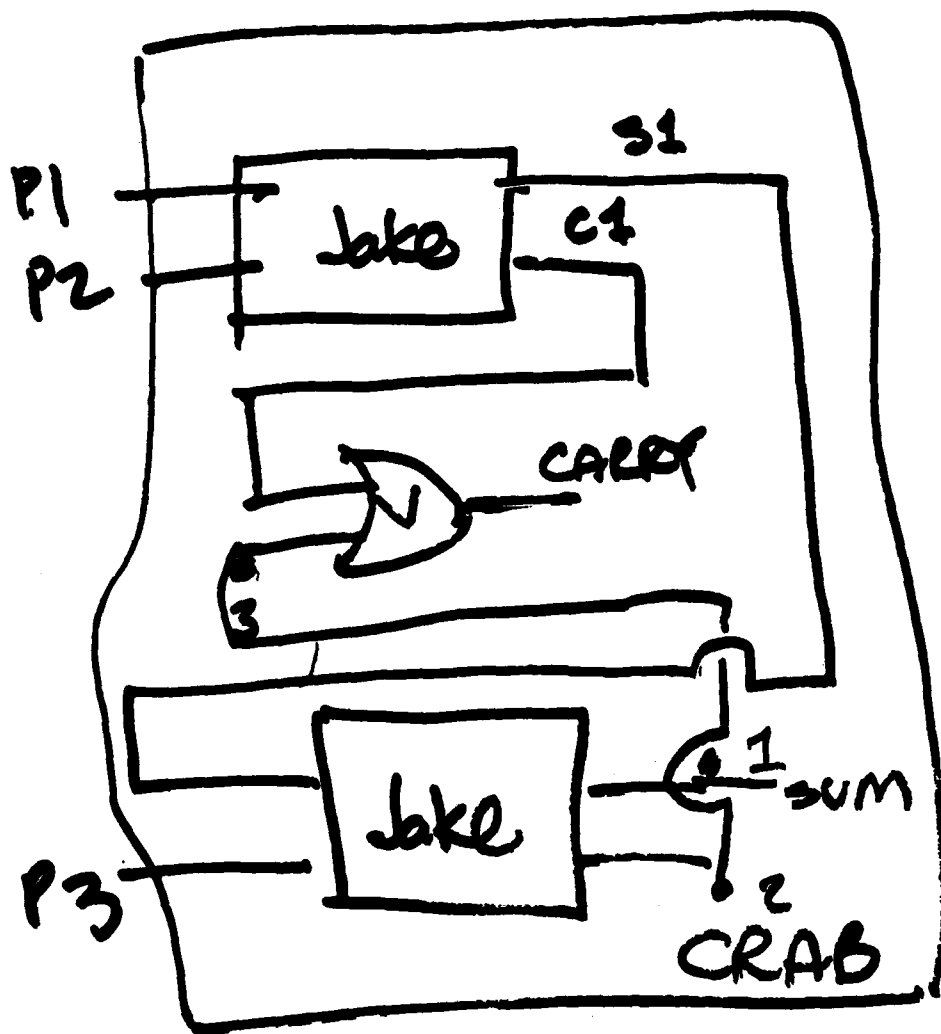
Session 6-2



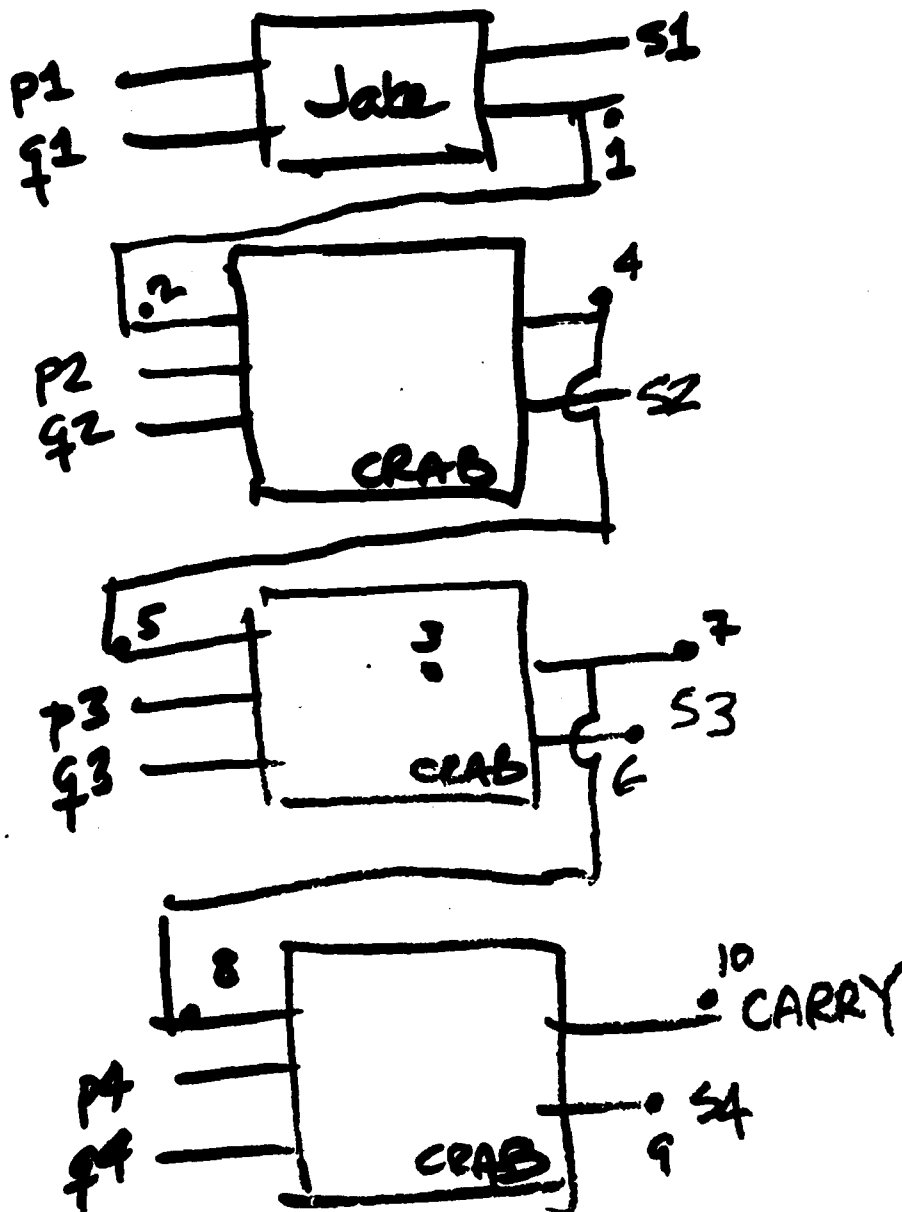
Session 6-3



Session 6-4



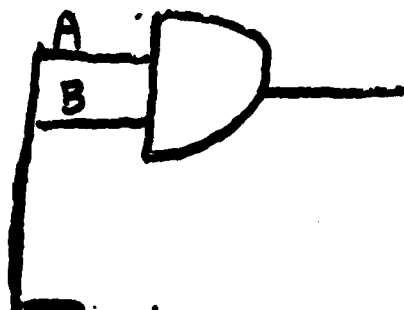
Session 6-5



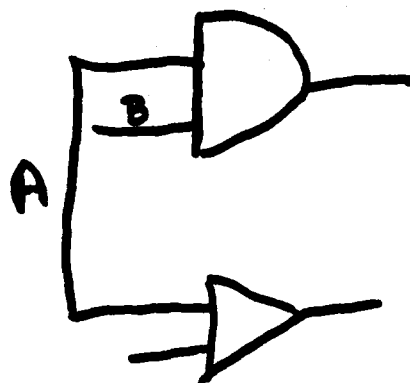
Session 6-6

APPENDIX G
SLIDES FROM PRELIMINARY PROTOCOL ONE

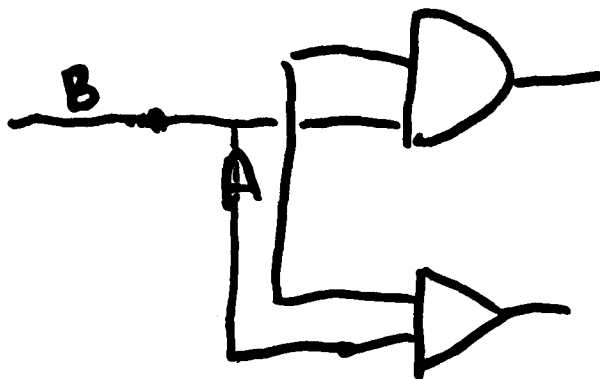
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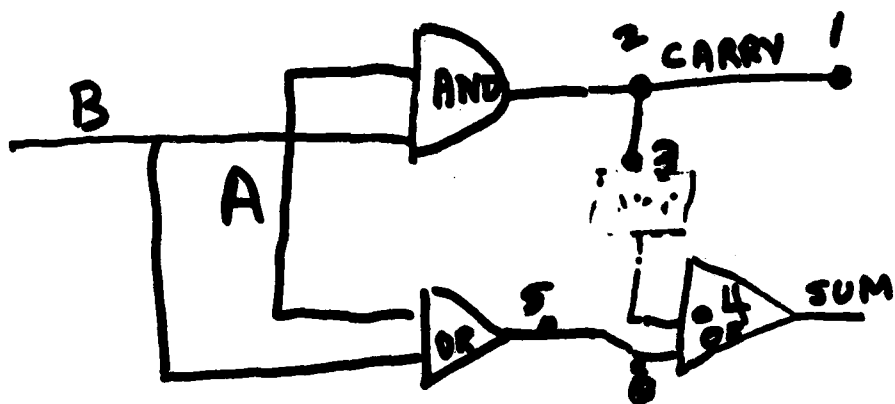
Prelim 1-1



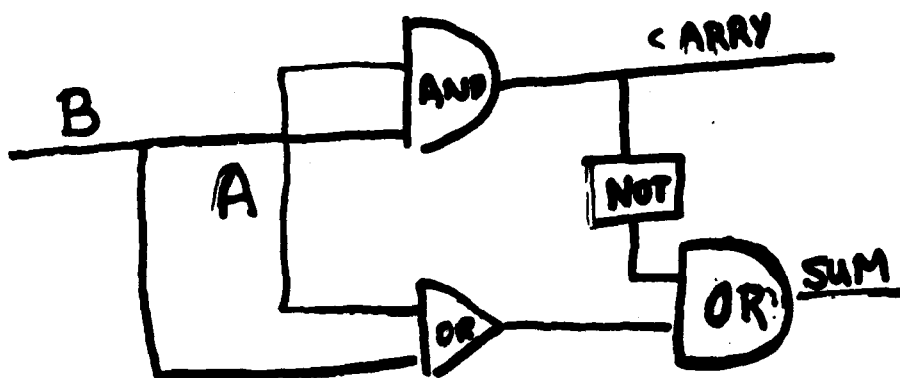
Prelim 1-2



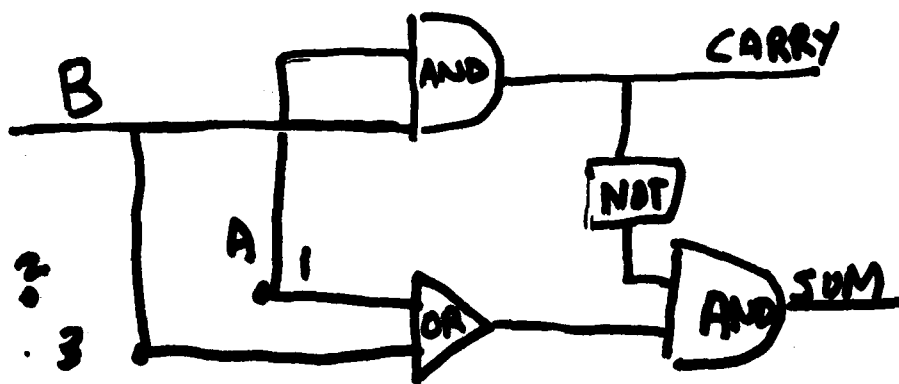
Prelim 1-3



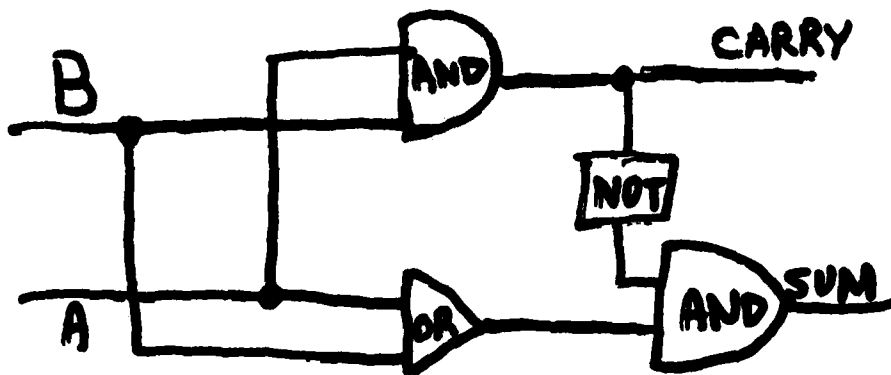
Prelim 1-4



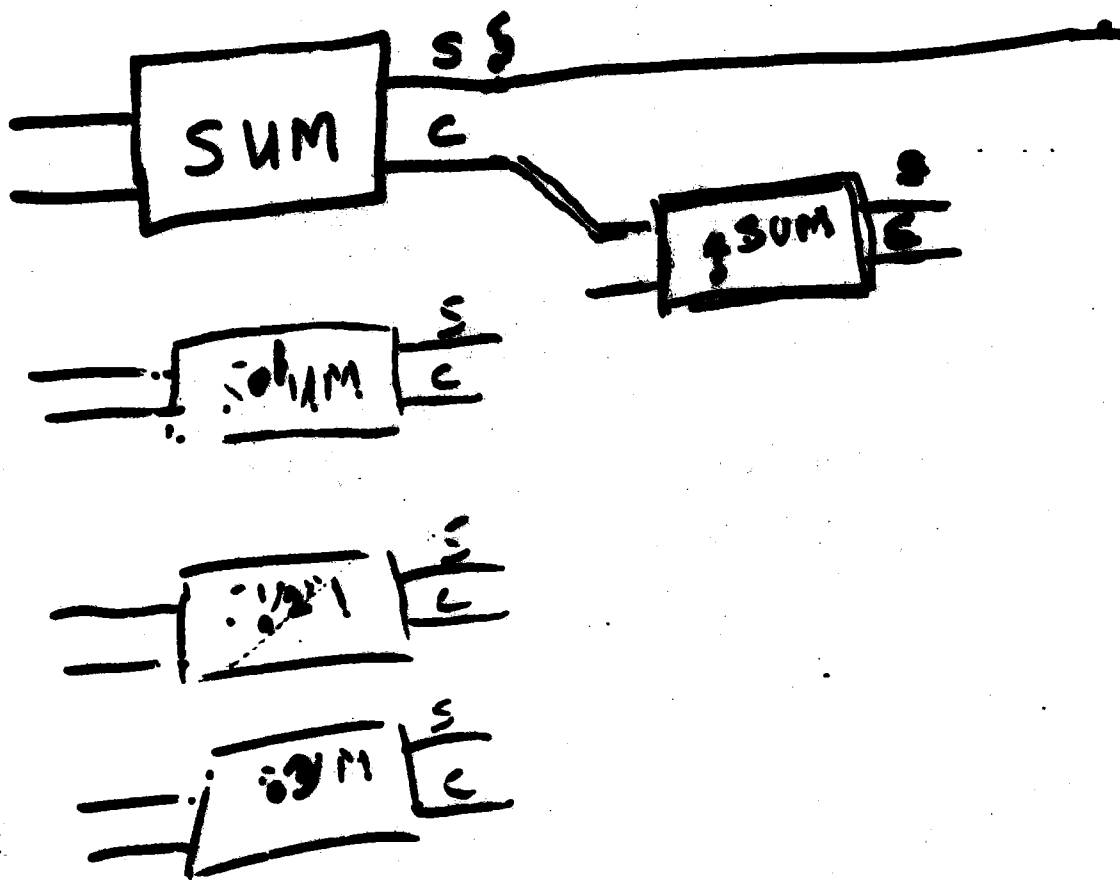
Prelim 1-5



Prelim 1-b



Preliml-7



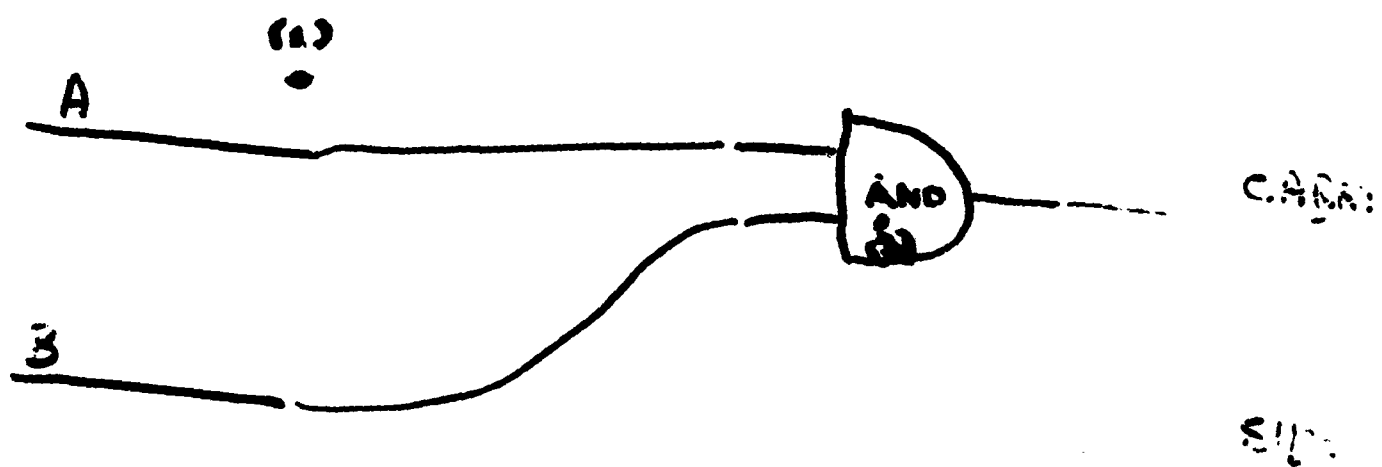
F Prelim. 1-8

APPENDIX H

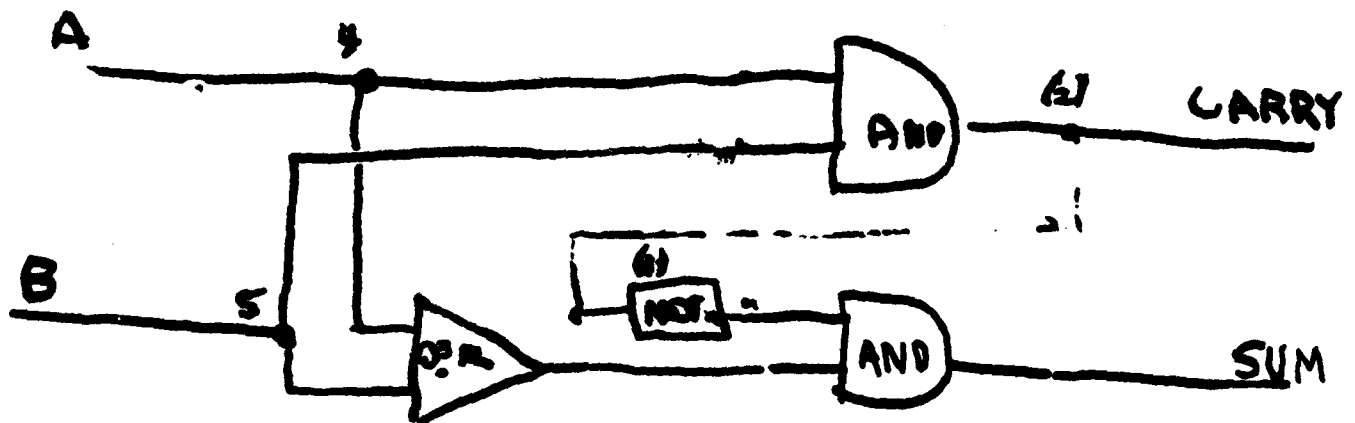
SLIDES FROM PRELIMINARY PROTOCOL TWO

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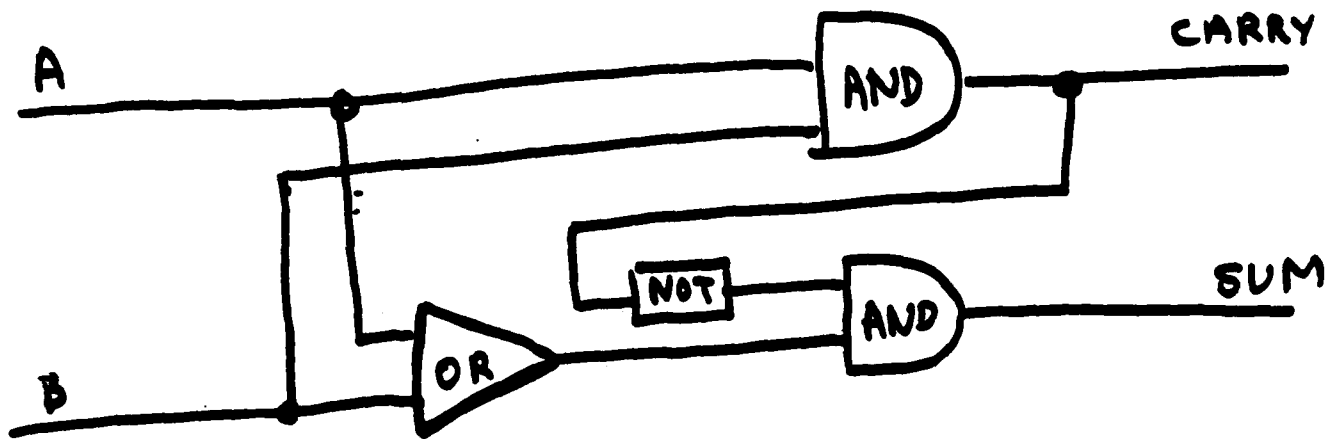
1



prelim 2-1



Prelim 2-2



Prelim2-3

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